JUN 4 1928

Compressed Air Magazine

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JUNE, 1928

CIRCULATION THIS ISSUE
30,811 *COPIES*

GAS AND COMPRESSED AIR ARE USED TO CLEAN METAL SURFACES BEFORE SPRAY-PAINTING NEWLY ASSEMBLED TRACTORS

History of the Hecla Mine in Idaho
J. F. McCarthy

Bellingham's Coal Mine a Busy One
C. W. Bucklew

Mohave Desert a Source of Potash
R. G. Skerrett

Oil-Engine Compressors at Congreso Mine
J. H. Roebuck

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n-810-LC

Waukesha-Equipped P & H Shovel on Cuban Central Highway

Libre Cuba con el Waukesha

Thirty years ago the Maine was blown up at Havana. American intervention lifted the Spanish Yoke. Now modern gasoline-driven machinery is freeing Cuba from her medieval roads that only the high-wheeled, slow-going ox-carts could navigate. Today 14 P&H shovels powered with Waukesha Ricardo Head Engines are busy at work on the great 700-mile Cuban Central Highway, that will cost over $75,000,000 in the next 10 years.

Tropical work is a great test of engine cooling. One of the important characteristics of the "Ricardo Head" is that it makes an engine run cooler when under heavy load. In this service reliability is another essential requirement, for repair parts may be weeks away. Simplicity of design is also important, permitting field service to be quickly given when required. Power, simplicity and reliability are outstanding features of all Waukesha engines. That is why more power shovels are equipped with Waukesha engines than any other make.

N-827-LC

INDUSTRIAL EQUIPMENT DIVISION

WAUKESHA MOTOR COMPANY

Waukesha **Wisconsin**

New York	Tulsa	Houston	San Francisco
8 W. 40th Street	*C. F. Camp Co.*	*Portable Rig Co.*	*C. A. Watts*

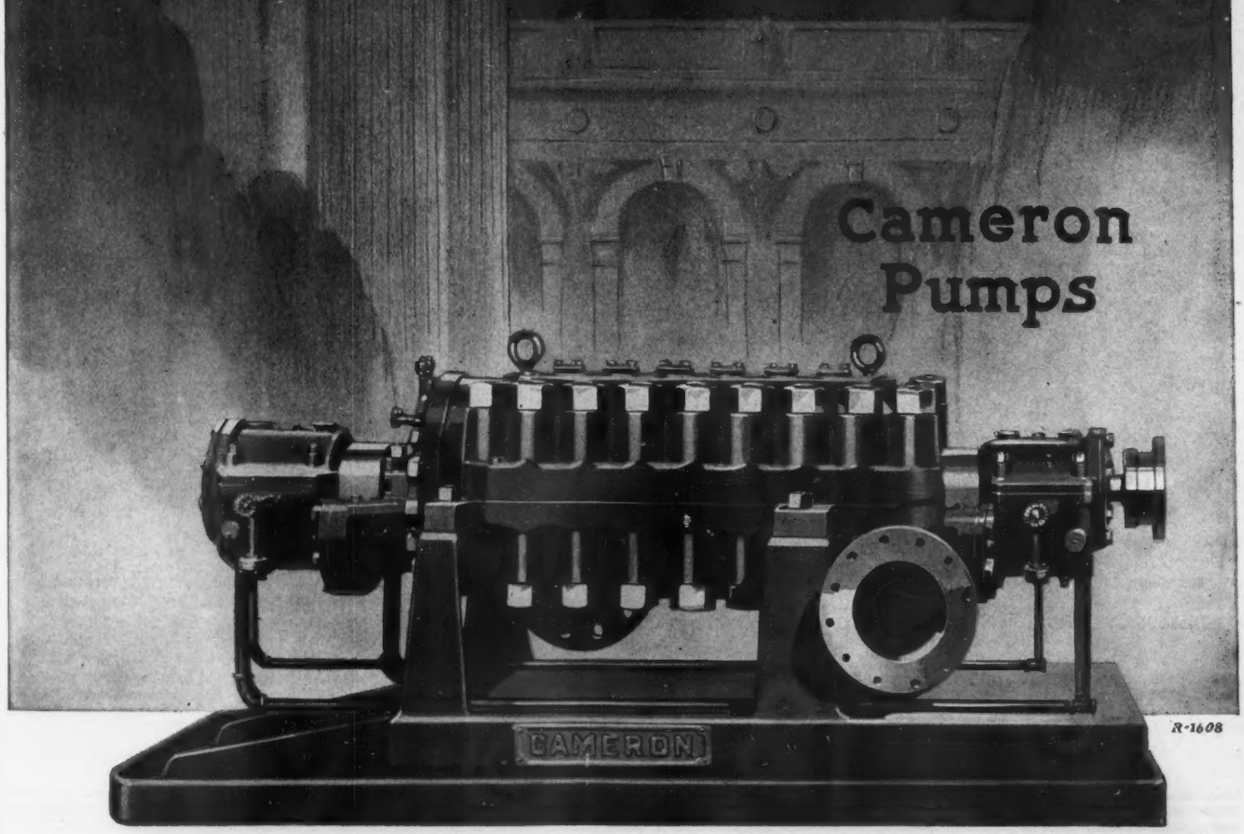
Exclusive Builders of Heavy-Duty Gasoline Engines for Over Twenty Years

APPEARANCE

It is peculiarly true of machinery that if it is built right it will look right. Cameron Pumps have a distinctive appearance that argues well for the correctness of their design.

Ingersoll-Rand

11 Broadway, New York



If you had a Prest-O-Weld outfit you could make more money

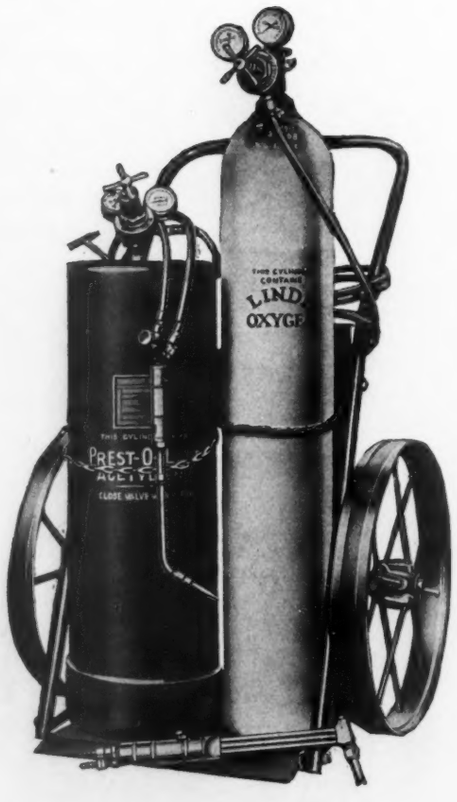
JUST stop and figure out how much profit there is in welding jobs.

Then you will know why so many garages and repair shops are buying Prest-O-Weld outfits.

Prest-O-Weld blowpipes are made by the Oxweld Acetylene Company, makers of the famous Oxweld equipment.

You will be agreeably surprised at the price.

Sold by jobbers everywhere.



OXWELD ACETYLENE COMPANY
Unit of Union Carbide and Carbon Corporation

UCC

CHICAGO
3642 Jasper Place

NEW YORK CITY
Carbide and Carbon Bldg.

SAN FRANCISCO
8th & Brannon Sts.

PREST-O-WELD

A plain statement of facts

MORE than twenty years ago the first commercial oxygen for welding and cutting was produced—Linde Oxygen.

From that day on, Linde has been the standard with which all others are compared.

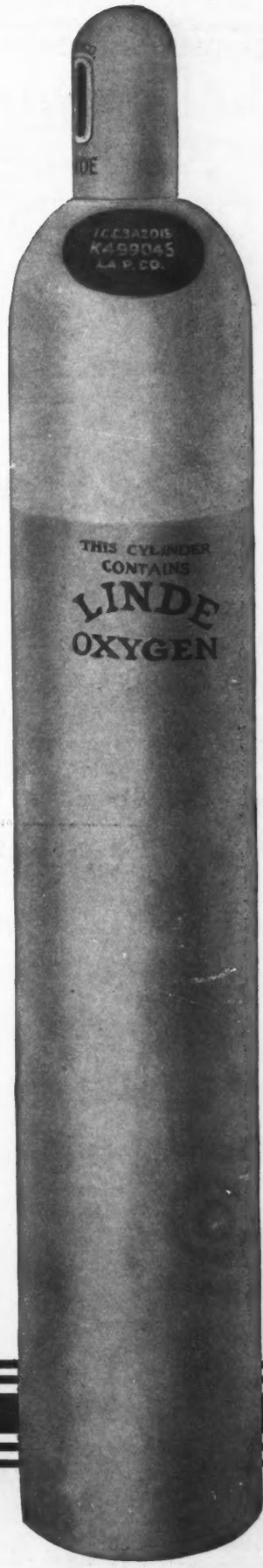
It has always had by far the largest sale of any oxygen.

There are three reasons for this:

—uniform high quality

—immediate delivery

—Linde Process Service—that insures the most economical results for Linde customers.



THE LINDE AIR PRODUCTS CO.
Unit of Union Carbide and Carbon Corporation
49 PLANTS UCC 102 WAREHOUSES
General Offices: Carbide and Carbon Building
30 East 42d Street, New York

LINDE OXYGEN

There is no mystery in the success of

Prest-O-Lite
DISSOLVED ACETYLENE

A record of 23 years of uniform high quality, and delivery service from 37 plants and 102 warehouses, has established a national preference for Prest-O-Lite.

Tens of thousands of acetylene users rely on Prest-O-Lite for all their oxy-acetylene welding and cutting work.

Such confidence must be deserved.

THE PREST-O-LITE COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

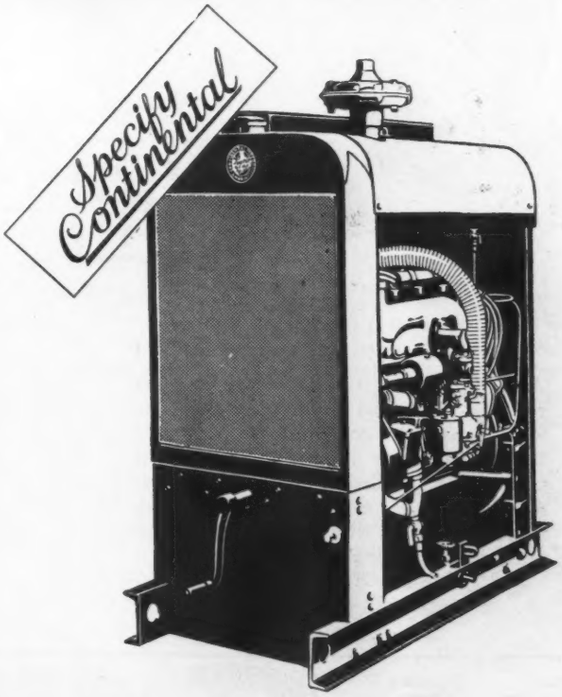
UCC

General Offices: Carbide and Carbon Building
30 East 42d St., New York
31 Plants—102 Warehouses

Dependable Power for Every Purpose

Long Life— Less Expense

Cutting operating costs, getting more production out of the day's work, showing greater profits on the month's effort—users of Red Seal Continental motors are accomplishing these as well as securing many other advantages. And whether it be in mine or on railroad, in oil field or road building, there is a particular type of Red Seal Continental motor to do the work, quickly and economically.



CONTINENTAL MOTORS CORPORATION
INDUSTRIAL EQUIPMENT DIVISION
Office and Factory: Muskegon, Michigan
The Largest Exclusive Motor Manufacturer in the World

Continental Motors

On road-building work, I-R "Jackhamers" and Portable Compressors are an ideal combination for the contractor

"Jackhamer" Rock Drills, in operation

Are you one of the 125,000 who have received, and read, "100 and 1 Ways to Save Money with Portable Compressors"? If not, write our nearest Branch for a free copy. The book contains 140 pages, 300 pictures, and many tables of authentic cost data. It will remain a valuable reference book for years to come.

These Machines Aren't Fair-Weather Friends

It takes a good rock drill to make headway on work like this. Maybe that's why the job went so fast. All the drillers were equipped with I-R "Jackhamers," and the air was kept up to pressure by Ingersoll-Rand Portable Compressors.

Give the road builder credit for the great work he is doing. Ours are the best roads in the world. The network of the fine highways that link up the country are a credit to the contractor, his methods, and his equipment.

Wherever there's road-building, I-R machines are sure to be found. Those most commonly used are Portable Compressors, "Jackhamer" Drills, "Leyner" Sharpeners, and Paving Breakers. In addition, however, there is a very complete line of pneumatic tools, many of which are designed particularly for the contractor's use.

There is an Ingersoll-Rand Branch near you. At this Branch you can obtain expert engineering assistance, competent mechanical service, and prompt deliveries of machines and spare parts.

Atlanta	Duluth	Philadelphia	Cobalt	Havana	Durban	Melbourne	Semarang
Birmingham	El Paso	Picher	Montreal	Mexico	Glasgow	Milan	Shanghai
Boston	Hartford	Pittsburgh	Nelson	Antofagasta	Iquique	Oruro	Soerabaja
Buffalo	Honolulu	Pottsville	St. Johns	Barranquilla	Johannesburg	Osaka	Stockholm
Butte	Knoxville	Salt Lake City	Sherbrooke	Batavia	Kalgoorlie	Oslo	Sydney
Chicago	Los Angeles	San Francisco	Sydney	Bombay	Kobe	Paris	The Hague
Cleveland	Manila	Scranton	Toronto	Brussels	Lima	Rangoon	Tokyo
Dallas	Newark	Seattle	Timmins	Buenos Aires	London	Rio de Janiero	Tucuman
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						Sekondi	Yokahama

Portable Compressors and CC Paving Breakers on a big street-repairing job

The Right Stuff Is Built Into Them

It will take more than a wheelbarrow to haul away the broken pavement shown above. CC Paving Breakers are the hardest-hitting, deepest-cutting tools of all, and they simply spell Distress to old and traffic-worn pavement.

The operators didn't waste any time ripping up those chunks you see in the picture. Concrete, asphalt, and other forms of street covering don't offer much resistance to the CC-35.

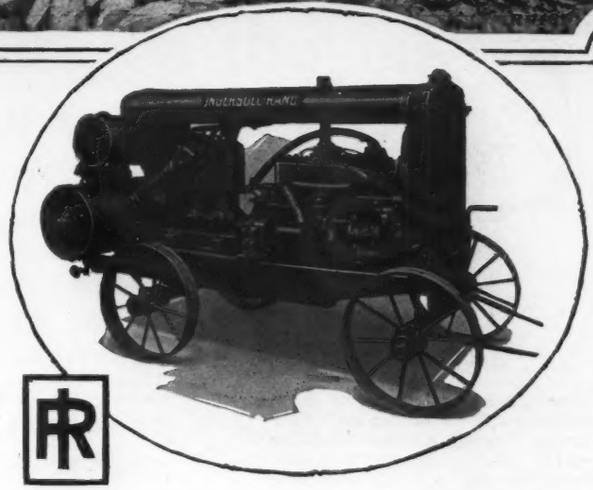
Public utilities, city street departments, and engineering corporations use these outfits when they want to do a job and do it thoroughly. I-R Portable Compressors are built in six sizes, with varying capacities, and there are also two distinct types of Paving Breakers. It is possible, therefore, to secure an outfit that will exactly suit your job. Every unit, large or small, carries Ingersoll-Rand backing and service.

You can't get better machines than these. Ask for literature or an actual working demonstration.

INGERSOLL-RAND COMPANY

11 Broadway **New York City**

Offices in principal cities all over the world



Type 20 Portable Compressor

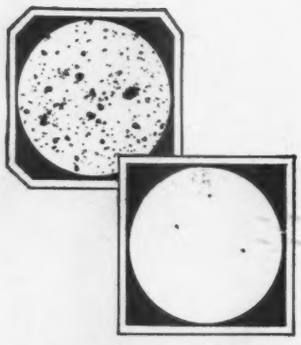
Ingersoll-Rand Portable Compressors are built in the following sizes: 4½ in. x 4 in., 5½ in. x 5 in., 7 in. x 6 in., 8 in. x 6 in., 9 in. x 8 in., and 10 in. x 8 in. Each will operate different combinations of Rock Drills, Paving Breakers, or other pneumatic appliances.

In designing these units, we have included many special points not usually found in other types of portable compressors. Upon request, we shall be glad to supply bulletins explaining in detail their features of design and construction.

145-PC

Ingersoll-Rand

He Thought the Air Was Clean, BUT - - - - - - - -



These micro-photographs show ordinary city air before and after passing through a Reed Air Filter —97% of all dust, dirt and soot removed. Reed Filters—a type and size for every engine and compressor, easily and inexpensively attached to the air intake—increase the life and efficiency of your equipment from 50% to 75% and cut repair bills one half.

MAKE THIS TEST YOURSELF!

Send today for a Reed Visual Dust Comparator—free of charge. Suspend it in the intake of engine or compressor. Note the constant accumulation of dust, dirt and grit. It will prove to you, in your own plant, the real need and actual economy of Reed Air Filters.

THIS DIRT

Was Ruining His Equipment!

AN OWNER of engines and compressors thought the air in his plant was so clean that Reed Air Filters were unnecessary. The air *looked* clean, but a test proved that an average of one pound of dust, dirt and grit was being drawn through the air intake of a 750-C. F. M. compressor *every week!* No time was lost in protecting his equipment with Reed Filters.

Are these dangerous abrasives, *unseen in the air,* finding their way into *your* valuable equipment, mixing with the lubricating oil, scoring pistons and bearings, reducing efficiency and bringing on premature depreciation? Make the test described on the left *and know the facts!*

REED AIR FILTER CO., *Incorporated*
214 Central Ave., LOUISVILLE, KY. *Representatives in Principal Cities*

Reed Air

TRADE *filters* MARK *ALL METAL*

---- *Use This* ----

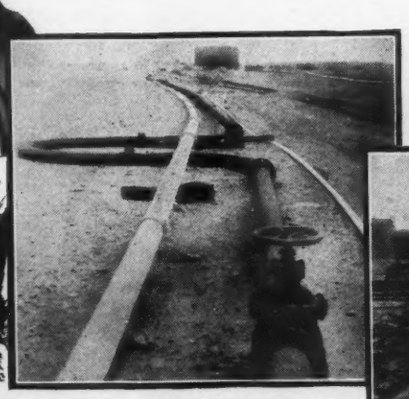
REED AIR FILTER CO., *Incorporated*
214 Central Ave., Louisville, Kentucky

Send, without obligating me, your Bulletin No. 110 on clean air for Air Compressors, Internal Combustion Engines and Pneumatic Equipment. (Check here ☐ if you wish a Reed Dust Comparator for testing air at intake).

Name..... City..... Possible Use.....

Company..... State.....

Victaulic Couplings for mid-continent oil line.



Victaulic Couplings eliminate need for expansion bends in Peru.

Victaulic Couplings gathering lines in Venezuela

Victaulic Couplings

"For every joint on the line"

THESE Victaulic-coupled crude oil, natural gas and water lines in the oil fields of tropical Peru, illustrate the economy in pipe, labor and fittings that Victaulic Couplings make possible.

"Formerly we had to use a large number of expansion bends to allow for contraction and expansion caused by the large difference in temperature during the twenty-four hours", writes the Vice-President of this large oil company, "whereas, owing to the flexibility of the lines connected with Victaulic Couplings we have cut out the use of expansion bends entirely."

* * * *

Victaulic Couplings suited this job. Unskilled labor laid the lines. The average time for connecting two lengths of pipe with Victaulic Couplings is two minutes. The couplings cannot go together wrongly. When the bolts are pulled up tight the sealing ring is centered automatically and the connection is permanently leak-proof even under severe vibration, line pressure shocks, shifting or sagging of the line or contraction and expansion of the pipe lengths.

Victaulic Couplings are supplied for all sizes of steel, wrought iron and cast iron pipe, for all pressures from vacuum to ten tons pressure per square inch.

"For every joint on the line" *All-purpose couplings*

VICTAULIC COMPANY OF AMERICA
26 Broadway, New York

FLEXIBLE LEAK-PROOF
VICTAULIC
REG. U. S. PAT. OFF.
PIPE COUPLINGS

For detailed information and list of uses and users, fill in and mail the coupon.

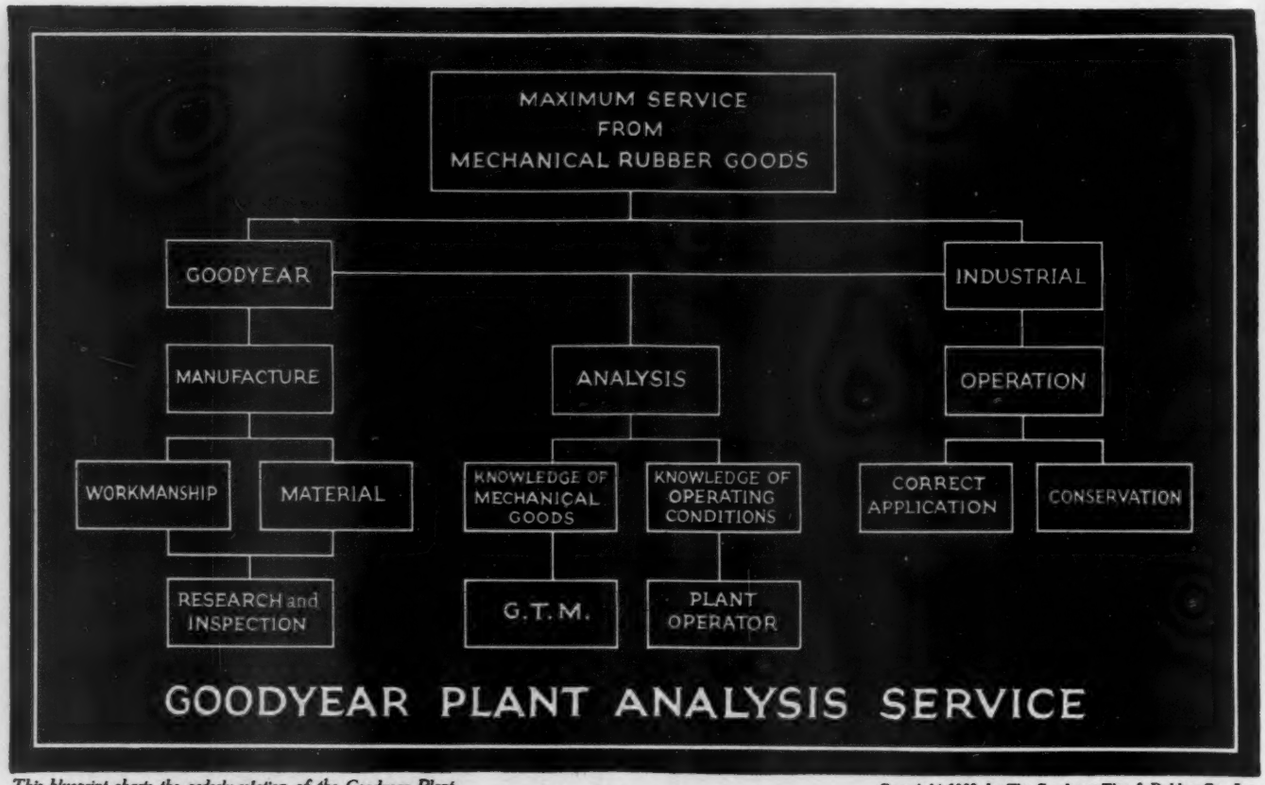
VICTAULIC COMPANY OF AMERICA
26 Broadway, New York

Please send Victaulic Bulletin No. 5 to

Name .....

Address.....

FOR CRUDE OIL · GAS · WATER · SEWAGE · COMPRESSED AIR, ETC.



This blueprint charts the orderly relation of the Goodyear Plant Analysis Plan for maximum service from mechanical rubber goods.

Copyright 1928, by The Goodyear Tire & Rubber Co., Inc.

The Plant Analysis Plan—and the G. T. M.

This chart is important to every man who has to deal with belting, hose or packing problems. It shows the principal factors in the Goodyear Plant Analysis Plan, and makes clear the part that is played in more efficient, economical plant equipment by the G. T. M.—Goodyear Technical Man.

You know the idea behind the Goodyear Analysis Service. It is simply this, that you are bound to get more work and better work, done more efficiently and more economically, from the *right* mechanical rubber goods, specified to the job. How the *right* product is found by analysis is shown on this blueprint chart.

At the top you see the G. T. M. and your plant operator, each applying his special experience and knowledge to the problem in hand, whether it be a single drive or an entire plant equipment. They make the analysis together.

The G. T. M. is an expert on mechanical rubber goods. He knows their special properties. He is trained in the science of their specification and application. His work takes him into many plants, in many industries, so that he is familiar with most transmission and conveying problems, and is a practical authority on many of them.

When he comes to your plant, he comes as a friendly analyst of your operating problems, your troubles, maybe. He doesn't pretend to know it all. He gladly takes the advice of your superintendent and engineer. He gives close attention to their experienced knowledge of your operating conditions.

His entire purpose is to fit what he knows about belting, hose or packing to the demonstrated conditions of service in your plant. If he can find out what you can use to best advantage, he will recommend it to you. Then, on your order, Goodyear will build your equipment according to those approved specifications. And after it is installed, the G. T. M. will follow it up with a service that will see that you get out of your equipment all the value built into it by this scientific analysis and careful manufacture.

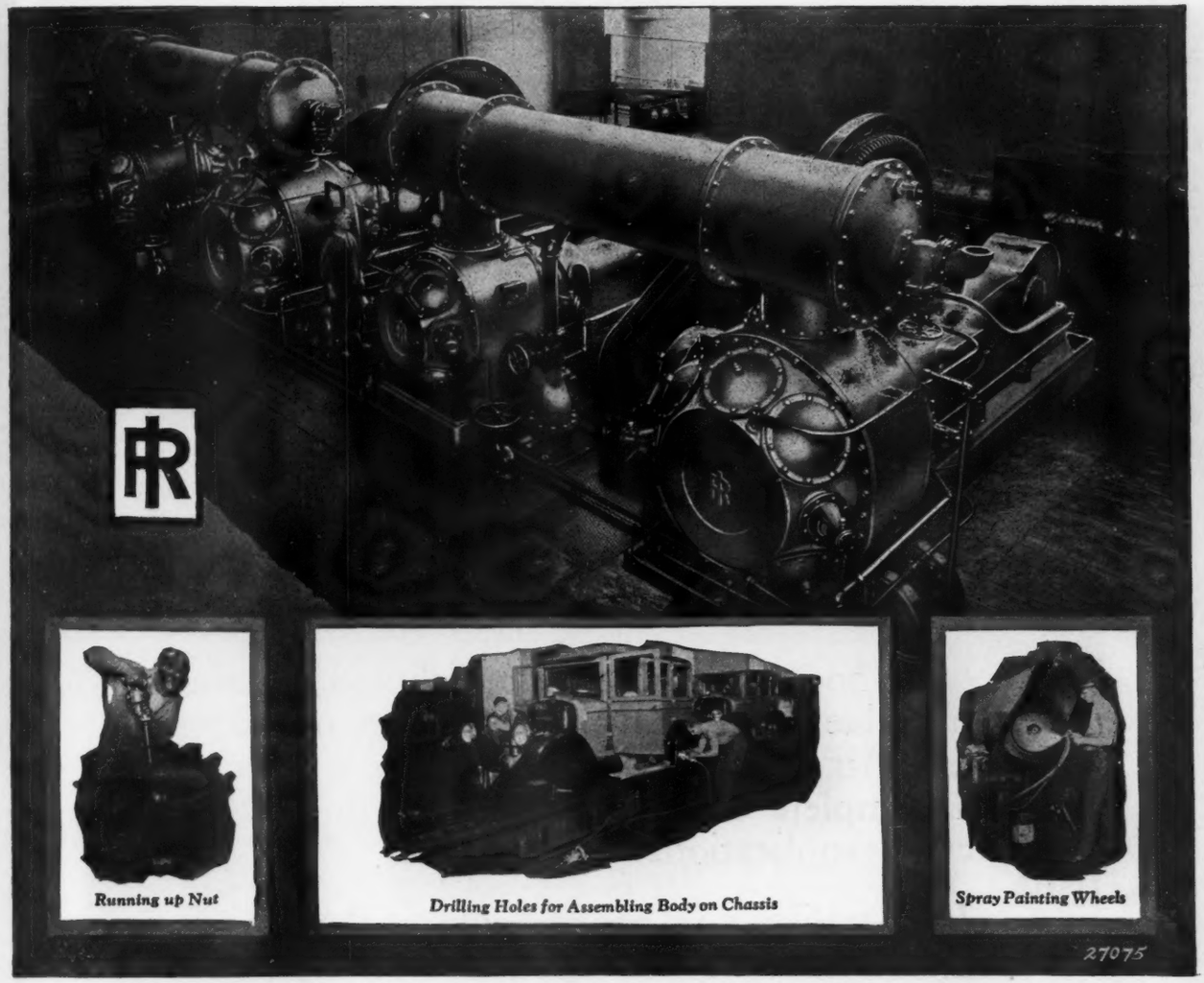
Doesn't it stand to reason that you are likely to get the utmost in trouble-free, long-wearing service out of that kind of equipment? The proof of the Goodyear Analysis Plan is in the records—many of them published in these pages during the past ten years—of better, more productive and more economical work done by G. T. M. specified goods in hundreds of plants, in every line of industry.

There is a G. T. M. in your neighborhood. It may pay you well to have him analyze your needs or problems. If you want to get in touch with him, or receive detailed information about the service Goodyear Mechanical Rubber Goods—belts, hose, valves and packing—are giving in your particular industry, write to Goodyear, Akron, Ohio, or Los Angeles, California.

Goodyear Means Good Wear

VALVES · PACKING BELTS · HOSE

GOODYEAR



Two Ingersoll-Rand PRE-2 Compressors in the Elizabeth, N. J. Plant of Durant Motors, Inc.

Keeping the Assembly Line Moving

¶ Volume production has given us better automobiles at lower selling prices. In truly amazing numbers, shiny new cars come off the assembly lines. One by one they quickly take form.

¶ Speed is here the watchword. A few seconds saved on each operation means many more machines per day. Compressed air is an effective force in quickening the pace. Highly efficient pneumatic tools expedite the performance of countless tasks. Moreover, they insure uniform workmanship on every unit.

¶ Back of the assembly line and its endless procession of cars is the compressor plant. A never-failing air supply is vital to the maintenance of production schedules.

¶ Ingersoll-Rand Compressors are keeping the assembly lines moving in many of the large automobile plants. They have been chosen because of an enviable reputation for dependability—a reputation founded upon nearly three-score years of successful service.

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For Europe Refer—Ingersoll-Rand Co., Ltd., 165 Queen Victoria St., London, E. C. 4

901-C

Ingersoll-Rand

COMPRESSED AIR DATA

HANDBOOK OF PNEUMATIC ENGINEERING PRACTICE

THIRD EDITION

By W. L. Saunders

IN this book the author has gathered together formulae and data on the subject of "Compressed Air Engineering" data which is essential to a complete understanding of its theory and practical application.

It is unlike any other book on the subject, in that it involves no discussion of pneumatic machinery. The book confines itself strictly to those things which every user of such equipment should know if he is to derive the greatest benefit from his investment.

Price $3.00, Postage Prepaid

COMPRESSED AIR MAGAZINE

11 BROADWAY, NEW YORK, N. Y.

Catches All the DUST

SAND AND GRIT IN DIRTY AIR

Triples Life of Compressors, etc.

The Protectomotor Air Filter removes 99⁹⁄₁₀% of the dust, grit, sand, and other foreign matter from the air before it enters compressors, engines, blowers, compressed-air tools, etc. That keeps valves free from carbon—reduces carbon deposits 60 to 70%.

As a result 75 to 85% of the wear on moving parts is eliminated. Machines are kept new and more efficient so they will do more work and can be operated from three to five times longer than unprotected machines before overhauling is necessary.

Protectomotor

Sectional View of Model CP Pipe Line Filter

Protectomotor Pipe Line Filter

Pipe lines equipped with the model CP Protectomotor Filter will deliver clean, dry air for paint spraying, compressed-air tools, hoists, cleaning operations, agitating liquids, ice-making, chemical processes, etc.

It removes all water, oil, rust, scale and other foreign matter from air passing through pipes and prevents wear and damage caused thereby to tools and other compressed-air equipment.

The Protectomotor occupies small space. Costs but little to install and nothing to operate. Has no moving parts to wear or get out of order.

Easily cleaned in ten minutes while in operation. Cleaning is necessary only twice a year under ordinary conditions.

Made in sizes to meet every requirement. Over 250,000 Protectomotor Air Filters in use.

FREE Trial Offer

Let us send you a Protectomoter on 30 days' free trial. It it does not do all we claim, return it and the trial won't cost you a cent.

Write for booklet, or simply mail the coupon.

STAYNEW FILTER CORPORATION
103 N. Water St., ROCHESTER, N. Y.

PROTECTOMOTOR
REG. U. S. PAT. OFF.
Perfect Positive Protection
AIR FILTERS

STAYNEW FILTER CORP.
103 N. Water St.
Rochester, N. Y.

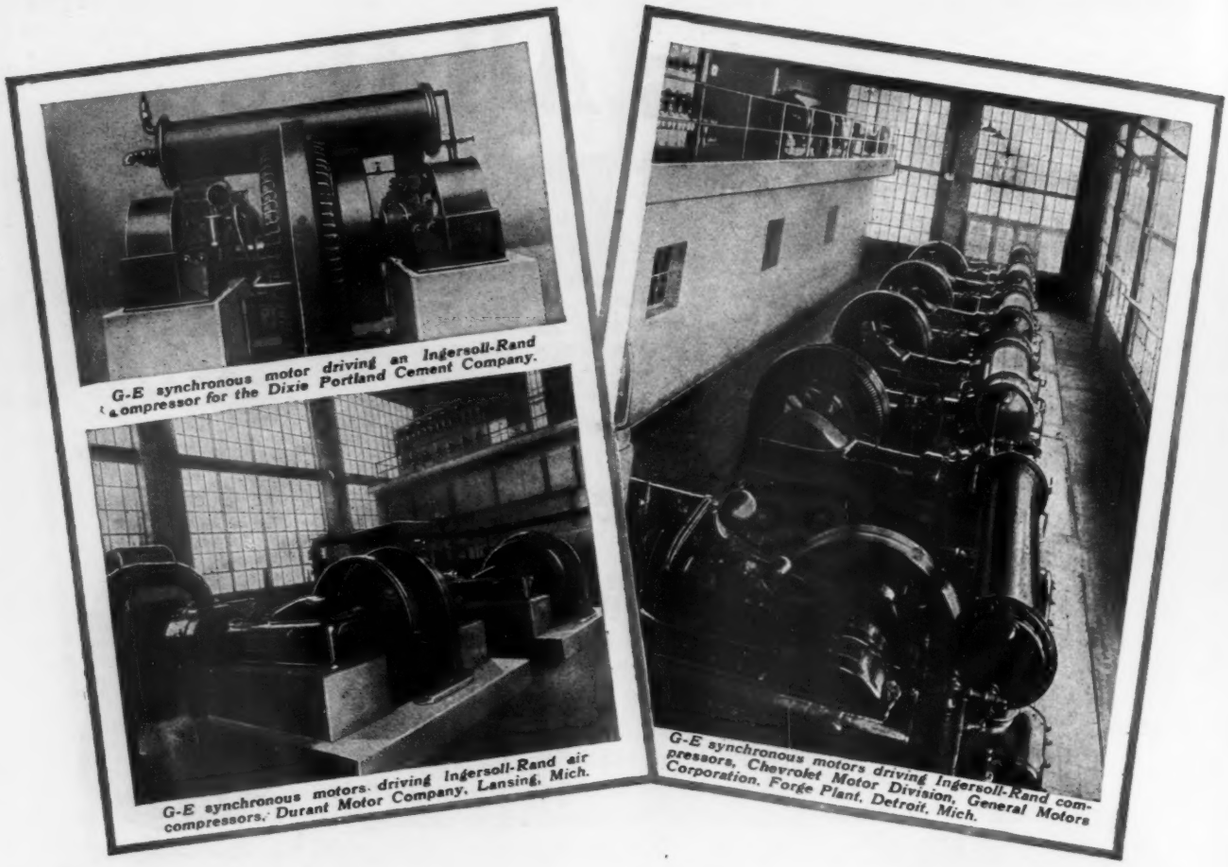
Please send copy of your Booklet on Protectomotor Air Filters.

To Use on_____

Name_____

Address_____

Town_____ State_____



G-E synchronous motor driving an Ingersoll-Rand compressor for the Dixie Portland Cement Company.

G-E synchronous motors driving Ingersoll-Rand air compressors, Durant Motor Company, Lansing, Mich.

G-E synchronous motors driving Ingersoll-Rand compressors, Chevrolet Motor Division, General Motors Corporation, Forge Plant, Detroit, Mich.

Where results must determine choice G-E Synchronous motors are selected

—because of their high efficiency, strong construction, ample torque, and unfailing dependability. These motors, in addition, are excellent improvers of power-factor, require very little floor space, and are particularly noted for longevity.

Their service in the drive of air compressors on such projects as the Catskill aqueduct, the New York subways, Muscle Shoals development, the Hetch-Hetchy, Moffat, and Shandaken tunnels has resulted in widespread indorsement.

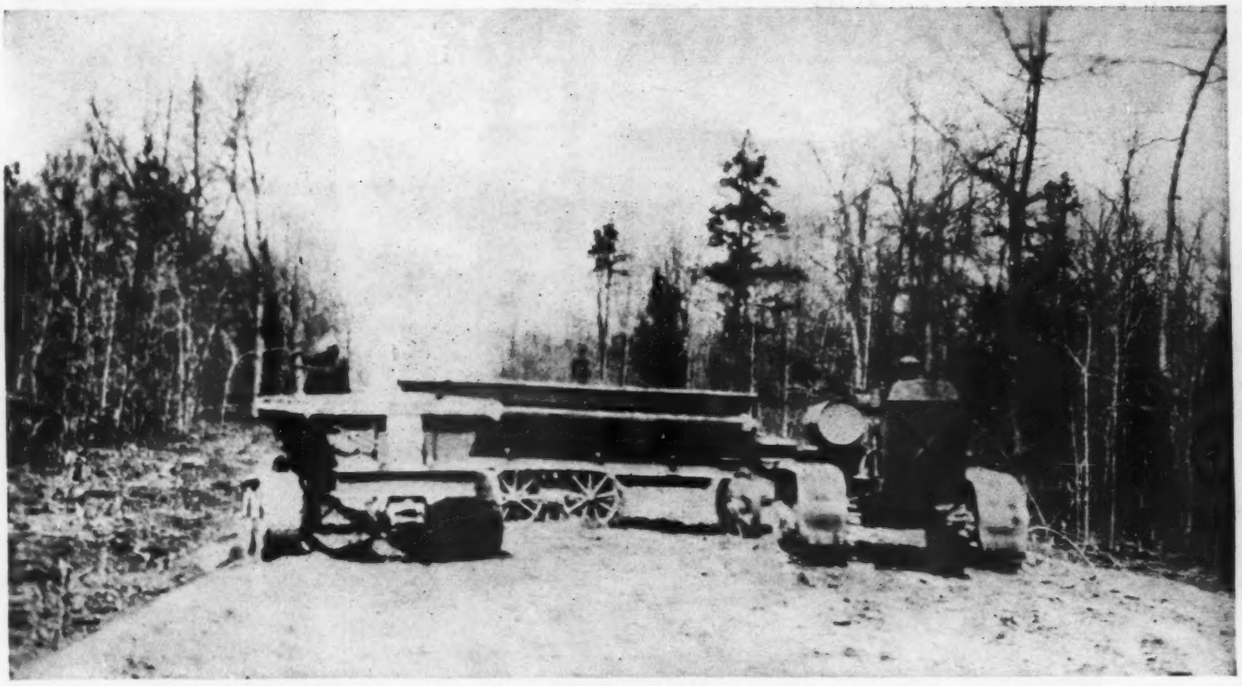
Their scope is extensive. A few installations are illustrated above. Users of G-E synchronous motors will tell you of the many advantages that are obtained. It is the most convincing evidence of their popularity.

G-E synchronous motors are made with the same high standard of quality which is characteristic of all other apparatus identified by this monogram.

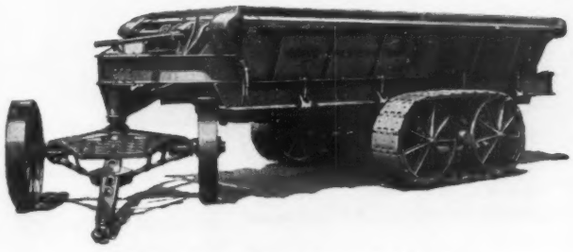
107-20

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES



A Motorized Unit—Crawler Tractor and two Crawler Wagons turning on a 30-foot fill.



90% of its load on Crawler Wheels.

One Contractor, operating three of these big wagons behind Crawler tractors on a haul of 1000 feet, averaged approximately 50 cubic yards per hour per wagon.

Seven Yards Regardless of Weather

There is a place for 7-yard Crawler Dump Wagons of such great efficiency at every industrial plant, as well as in contractors' outfits. This great wagon makes a powerful crawler tractor available for hauling material. Since its appearance last season it has been revolutionizing material haulage throughout the country. Used singly or in trains, carrying ninety percent of the load on broad Athey Truss Wheels that can go wherever and whenever your tractor goes.

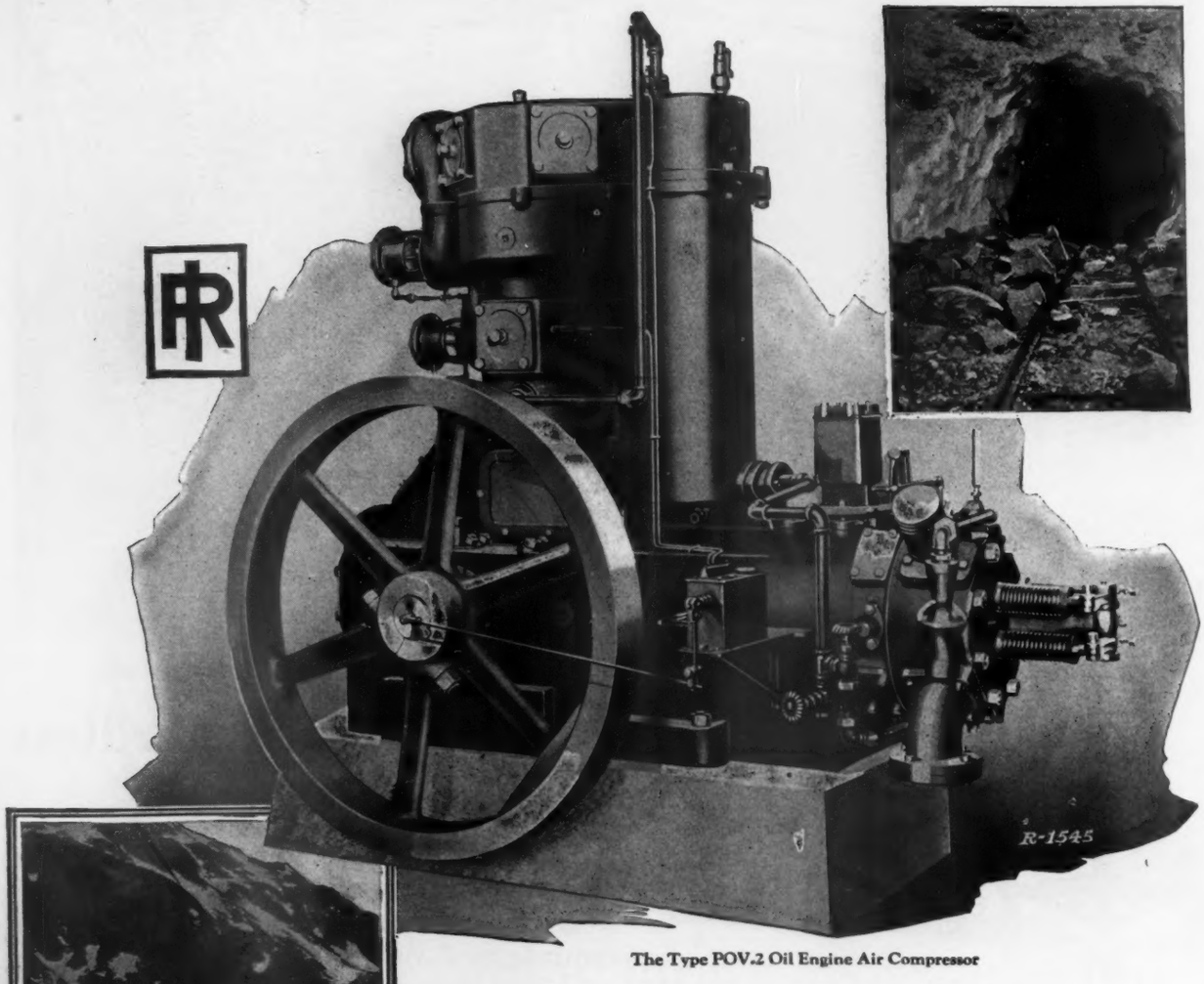
Bulletin 27-SCM gives full information. May we send you one? This wagon will help solve your haulage problems. Write today.

Western Wheeled Scraper Company
Aurora, Illinois

WESTERN

Western

DUMP CARS AND GRADING EQUIPMENT



The Type POV.2 Oil Engine Air Compressor

The Apex El Nido Mine near Juneau, Alaska.

Upper right—The upper tunnel portal of the Apex El Nido. It is necessary to tunnel through thirty feet of snow before the rock foundation can be reached.

Mining in Alaska with the Oil Engine Air Compressor

The Apex El Nido Mine, near Juneau, Alaska, uses an Ingersoll-Rand Type POV-2 Oil Engine Air Compressor for furnishing compressed air to I-R Rock Drills and Drill Steel Sharpening Equipment.

By using the oil engine compressor, the mine owners are assured of winter operation. Despite the severe weather conditions, a steady supply of compressed air is always available.

The POV-2 unit is compactly designed and occupies comparatively little room. Moreover, like other I-R Oil Engine Compressors, it operates at a very low figure, producing 1000 cubic feet of free air at a fuel cost of only 1.2 cents.

It is easy to install, easy to operate, and requires very little attention. We will gladly send you bulletin 10204.

INGERSOLL-RAND COMPANY, 11 Broadway, New York City

Offices in principal cities the world over

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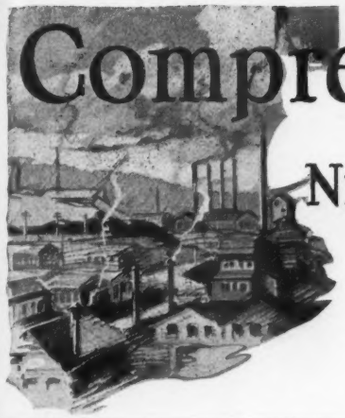
For Europe Refer—Ingersoll Rand Co., Limited, 165 Queen Victoria Street, London, E. C. 4

123-SOE

Ingersoll-Rand



Compressed Air Magazine

NEW YORK · LONDON · PARIS

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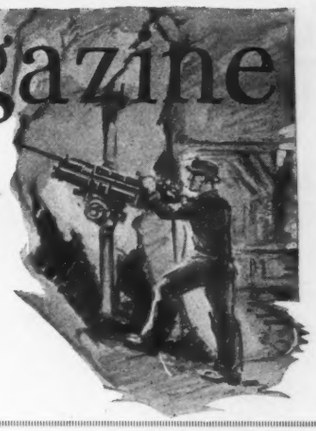

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Mohave Desert a Source of Potash

Saline Deposit in Searles Lake Now Being Exploited On a Large and Significant Scale

By R. G. SKERRETT

PLANT food from the desert! Plant food that makes the garden bloom and the farm bear more abundantly! Apparently a paradox, but nevertheless a fact, and all because of the skill and the patient work of the chemical engineer in converting to a useful form a seemingly unpromising raw material of nature's providing.

The story we have to tell is about a thriving industrial community nestling in that section of the Mohave Desert forming the valley between the Argus Mountains on the west and the Slate Range on the east. In this out-of-the-way northwestern corner of San Bernardino County, California, is being produced, mainly for the agriculturist, the largest percentage of potash of domestic origin. The magnitude of the plant engaged in this work is primarily the outgrowth of a potash shortage that confronted us during the period of the World War. Then, for the first time, the public at large had brought home to it how essential potash is to the well-being of the American people.

Just before that conflict began, the tillers of the soil were paying on an average $40 a ton for imported potash salts, used principally in the preparation of fertilizers. Before the close of 1914, the price of potash had risen to $450 a ton! There are certain crops, such as cotton, tobacco, potatoes, etc., that suffer when denied a sufficiency of potash during the growing period. Without enough of this energizing chemical, fruits and vegetables are deficient in palatable substance and flavor, and, similarly, flowers lack vigor and capacity to resist the diseases and the insects that inevitably attack floral weaklings. To what extent potash enters into the robust tree is evidenced by the percentage of potash that can be leached from the ashes of such a tree when burned.

While potash is employed in the manufacture of glass, in the making of explosives, and in some metallurgical activities, still 95 per cent of the quantity consumed in this country is utilized in enriching the soil for agriculture.

A POTASH famine confronted the United States when the World War cut off the country's principal foreign source of this essential plant food. For a while, American farmers were seriously handicapped in producing marketable crops of certain sorts. Potash, for which they had been paying on an average $40 a ton, suddenly mounted in price to $450 a ton!

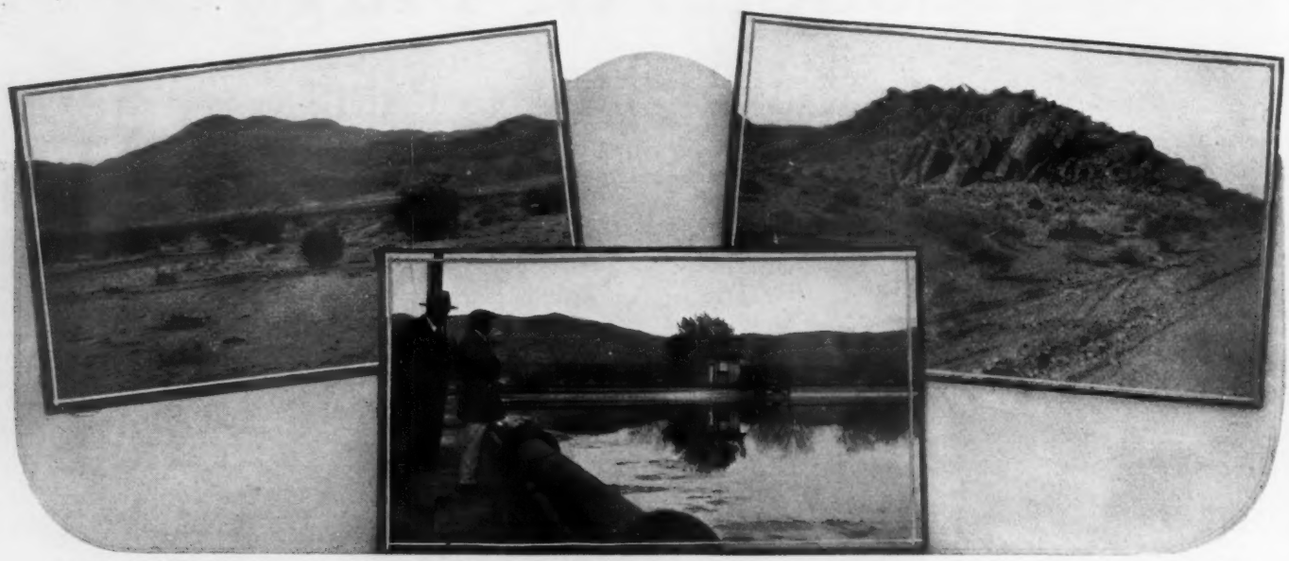
To relieve the situation, much experimental work was done in an effort to develop domestic sources of potash; and, thanks to these endeavors, means were devised that improved conditions greatly. Most of these undertakings were of a temporary nature, and ceased to operate a short while after international peace was restored.

There was one exception, however, and that was the efforts to make available potash contained in the brine of Searles Lake, in the Mohave Desert region of California. The experimental plant established there has since been developed into a commercial enterprise that is a monument to engineering skill and to chemical cunning and also evidence of the courage of the people that contributed to its ultimate and outstanding success.

Today, probably not more than 20 per cent of the potash needed for this purpose originates in the United States—the plant at Trona alone producing 16 per cent of this, while the remaining 80 per cent comes from abroad. This fact makes all the more important the splendidly significant work being done at Trona, in the Mohave Desert, by the American Potash & Chemical Corporation—the successor of the pioneer enterprise, the American Trona Corporation. Before describing what has been and is being done by this courageous concern, we should first sketch the circumstances that led to the founding of the plant and to the settlement at Trona, near the west shore of Searles Lake.

The term lake as applied to Searles Lake is something of a misnomer, except during the winter season when the rains of that brief part of the year overflow the salty crust that generally covers the more or less swampy bed of an erstwhile vast body of water. At other times Searles Lake is a shimmering expanse of salt having an area of 12 square miles—the crust being thick enough to sustain a motor car. This saline deposit in the center of the lake is the consequence of virtually continuous evaporation extending probably over an era of thousands of years.

There is ample evidence that Searles Lake, so called, was once a far larger body of water—the slopes of the flanking mountains showing plainly ancient shore lines more than 600 feet above the present surface level. Such was the condition when the snow and ice of the glacial age melted and filled the valleys between the mountain ranges. Those waters saturated the underlying earth and carried the mineral salts of the region, in solution, into the near-by basins—that of Searles Lake being but one of a number. In the course of eons, these very weak saline solutions became more and more concentrated; and Searles Lake, as it exists today, is the present



Left—A bit of the desert adjacent to Trona. Right—On the road to the Valley Wells. Bottom—Reservoir at Valley Wells that is used as a swimming pool in warm weather.

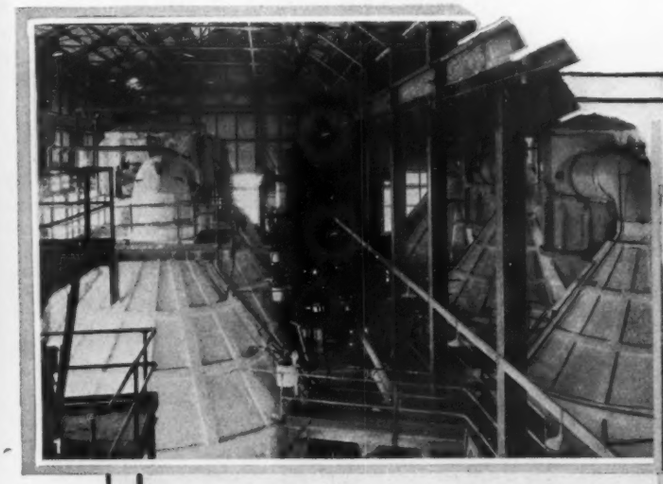
climax of this process of evaporation, induced by intense solar action for the greater part of every year.

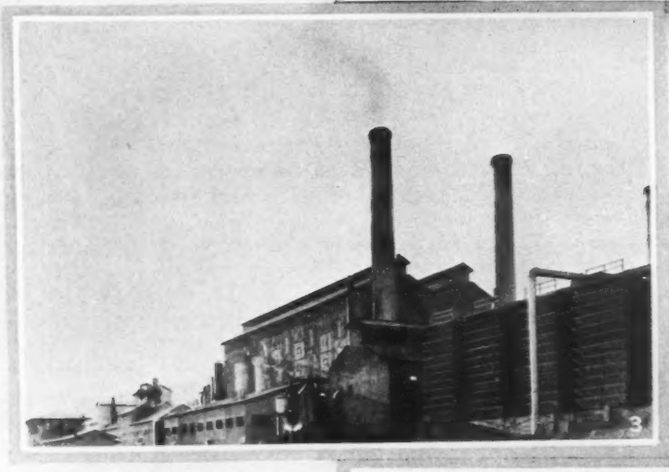
How dry the atmosphere usually is in the Mohave Desert can be gathered from the fact that a shirt washed just before the wearer takes a bath will be dry enough to don again well-nigh immediately afterwards; and a piece of bread cast on the ground after nightfall becomes a desiccated crust in a few minutes. The Mohave Desert is not devoid of vegetation, because here and there are scattered growths of greasewood, sagebrush, ghostly desert holly, and other forms of tenacious plant life that survive by reason of the brief rainy season and their capacity to draw moisture from the subsurface of an alkaline soil that is, for the most part, an arid waste.

To John W. Searles is generally attributed the discovery of the great salty deposit that now bears his name. This was in 1862, when Searles was prospecting for gold in the Slate Range. Eleven years elapsed, however, before Searles located mineral claims there, and he did that only when borax became an object of commercial quest. He recalled that the salty formation in that region was identical with samples of crude borax shown him. A borax company subsequently operated at Searles Lake; and it was not until 1898 that the lake was looked upon as a possible source of potash in valuable quantities. Little was done to realize on this until after 1912. In that year, two United States Government bureaus—the Geological Survey and the Bureau of Soils—issued the first bulletin which called to public attention the fact that Searles Lake was a potential source of potash. By 1914, the American Trona Corporation had an experimental extraction unit in course of construction at Trona—the object being to extract potassium chloride and other salts from the brine of Searles Lake.

To recognize the true character of this undertaking and to appreciate the difficulties that had to be overcome to blaze the way to successful operation it will be necessary to sketch briefly the physical conditions that had previously handicapped mining activities in that general region of wide-spread aridness and of infrequent water holes from which water could be obtained for men and beasts crossing that grim section of the country. Who was the first white man to look upon the

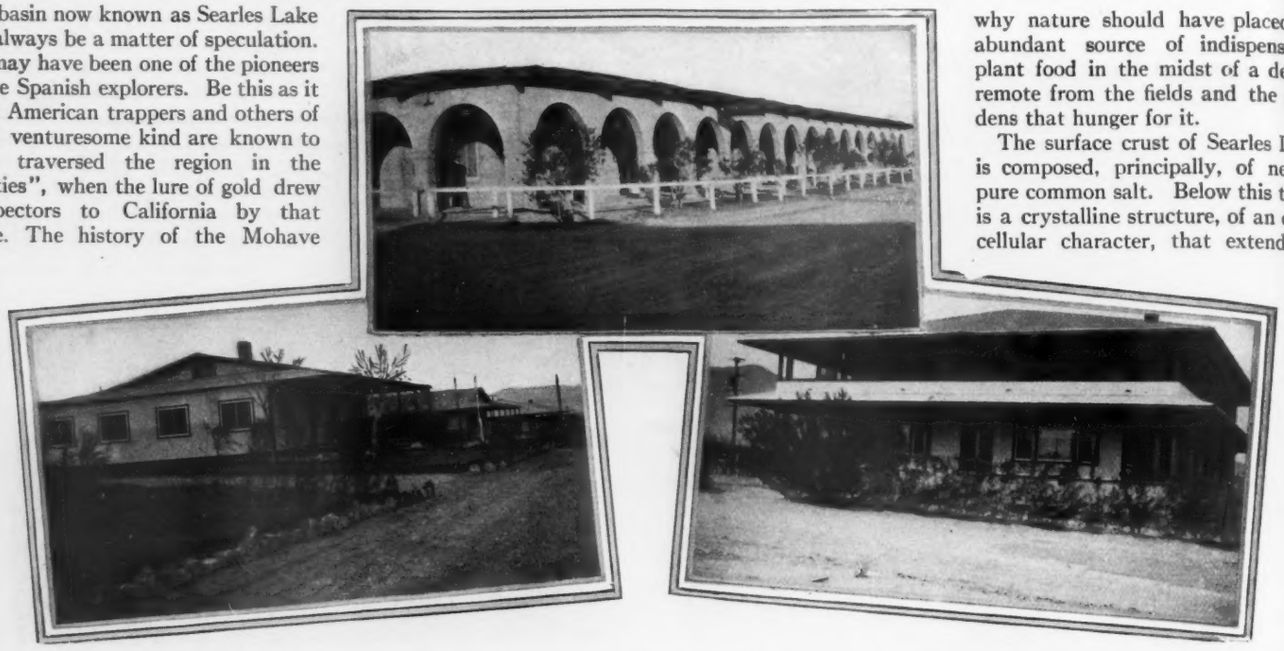
Top—Standing on the salty crust of Searles Lake. Left—The 4-mile pipe line that carries brine from the lake to the evaporating plant. Right—Pump house, on the shore of Searles Lake, that sends the brine to the plant.





1—Interior of the evaporator house. 2—Section of the Village of Trona. 3—Evaporator house and part of the cooling towers. 4—The plant at Trona as seen from the southwest. 5—Plant viewed from the north, with Searles Lake in the distance.

salt basin now known as Searles Lake will always be a matter of speculation. He may have been one of the pioneers of the Spanish explorers. Be this as it may, American trappers and others of their venturesome kind are known to have traversed the region in the "forties", when the lure of gold drew prospectors to California by that route. The history of the Mohave Desert is replete with records of what happened to many of those travelers when they lost their way and died of thirst in that forbidding expanse.



Top—Administration Building at Trona. Left—Some of the homes for the married personnel. Right—Club house.

The main problem for others, who followed later on and sought to profit by the mineral riches of the region, was one of transportation. The team of many mules, drawing its own supply of water with it, became, in time, the accepted medium for moving freight and passengers in and out of the Mohave Desert. This was before railroads radically altered the situation for the better by shortening the hauls from the mines to railhead. The American Trona Corporation, when it essayed in 1914 to prove conclusively that potash in paying quantities could be extracted from the brine of Searles Lake, realized that it would be necessary to link Trona with Searles Station, on the Southern Pacific, 31 miles away by the shortest practicable route. This line was started and finished in 1914; and over that road were transported to Trona the machinery, the associate equipment, and the various supplies needful to construct and to maintain the plant. In the same way were carried the materials required in building the camp for the workers and the food and other essentials incident to their sustenance.

From Searles Station to Trona there is a descent of about 1,600 feet, and the line follows 27 curves that have a total length of 9 miles in the course of a run of 31 miles. Because of this difference in elevation, the "Galloping Goose"—as the train is now called—is able to move downhill to Trona a load of 1,500 tons, and to haul upgrade from Trona to Searles Station a matter of 650 tons. The outward bound trip is a somewhat slow and toilsome climb: and in either case the austerity of the landscape makes one wonder why nature should have placed an abundant source of indispensable plant food in the midst of a desert remote from the fields and the gardens that hunger for it.

The surface crust of Searles Lake is composed, principally, of nearly pure common salt. Below this there is a crystalline structure, of an open cellular character, that extends to a depth of approximately 70 feet. The pores of this crystalline sponge, so to speak, are filled with a dense brine or saturated solution of fifteen ingredients, only two of which are extracted at the Trona plant. The brine is pumped from wells sunk in the cellular mass, and is piped a distance of about four miles from the lake to the evaporating equipment.

The desired potash and borax are obtained through a process of fractional crystallization—precipitation of the sought for crystals depending upon exact knowledge regarding the effects of temperature and concentration upon the treated brine. Let us be a little more specific, because the foregoing description sounds much simpler than the procedure actually is. The raw brine from the lake is mixed at the plant with various end-liquors produced during the process cycle. This mixture is then delivered to triple-effect evaporators that are much larger but in a general way similar to those employed in the refining of sugar. The object of passing the brine

Top—Quarters for unmarried personnel. Left—Trona's "Main Street" with kiddies coming from school. Right—Sleeping porch of quarters for unmarried personnel.

through the vacuum pans is to concentrate it by heating and boiling off a considerable percentage of its water content. The final stage of evaporation is carried out at the highest of three operating temperatures. During the three steps of evaporation the undesired constituents of the brine are crystallized and precipitated, after which they are removed from salt traps in the bottoms of the vacuum pans. These salts are returned to the lake.

The process of evaporation is continued to a point just short of that at which potassium chloride—muriate of potash—would begin to crystallize and precipitate. At this stage, the hot, concentrated brine is cooled sufficiently to induce the crystallization of a certain portion of the potassium chloride. This cooling is carried out in two stages. The first is brought about by subjecting the hot liquor to a vacuum that will cause it to boil, and so by this action cool itself faster, and the second also depends upon the effects of vacuum, but for this purpose the vacuum is of a higher degree.

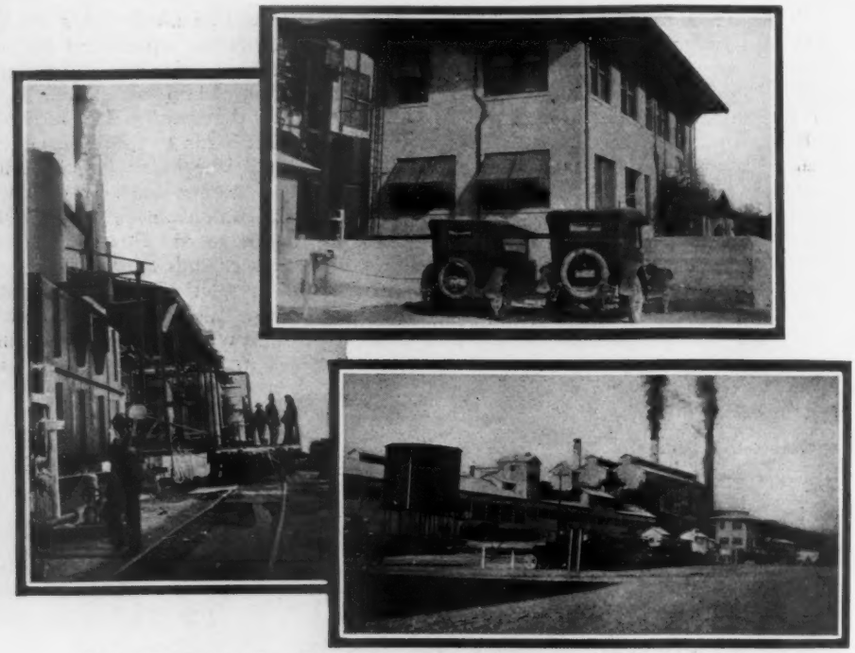
It will probably help to a better understanding of what the chemical engineer has achieved at Trona if the reader be reminded that the solubility curves of all the salts which are present in any quantity in the Searles Lake brine—except potassium chloride and sodium tetraborate—are relatively flat. That is to say, unless the process temperature is carried to a rather low point, these salts have the same solubility whether the solution be hot or cold, and do not crystallize and precipitate. On the other hand, potash and borax are much more soluble when hot than they are when cold, and, therefore, they can be concentrated in solution by means of evaporation and by forcing out, the while, some of the undesirable salts.

When the crystalline potassium chloride has been rapidly removed from the bulk of the brine liquor by means of continuous settling tanks, the sludge from these settlers is run through centrifugals by which the liquor is "thrown" out of the salt, which is then washed. The resulting potash goes thence to the storage pile. The mother liquor from which the potash was crystallized is next further cooled by refrigerated brine to bring about the crystallization of still more of the contained borax. This crude crystalline borax, after being separated from the liquor, is refined by a process of recrystallization, and is finally dried and screened before shipment. The mother liquors from both the crude and the refined borax are returned to be mixed with fresh lake brine in making up the feed for the evaporators—thus completing the cycle of operations.

The question will be asked: "How are the potash and the borax separated from one another?" The explanation is that if a nearly saturated solution of both potash and borax be cooled quickly the potash will immediately crystallize so that it can be readily separated by centrifuging. The borax, on the other hand, is a supersaturate, and none of it will crystallize for a considerable while after the potash has been removed. However, as soon as the first borax crystals appear the rest of the borax in the solution will very rapidly form into crystals. This, in brief, is the method employed at Trona to bring about the ultimate separation of the borax from the potash. With this accomplished, the salts are virtually ready for marketing.

On the face of it, it should be evident that temperatures, pressures, and the degrees of concentration must be watched carefully and continually, because activities at Trona go on without cease, day in and day out, and for weeks and months running. Furthermore, the commercial success of the work is to a large extent contingent upon the economical utilization of fuel and power. The present procedure is the climax of years of intensive research and costly experimenting; and it represents the surmounting of many technical obstacles and the neutralizing of difficulties

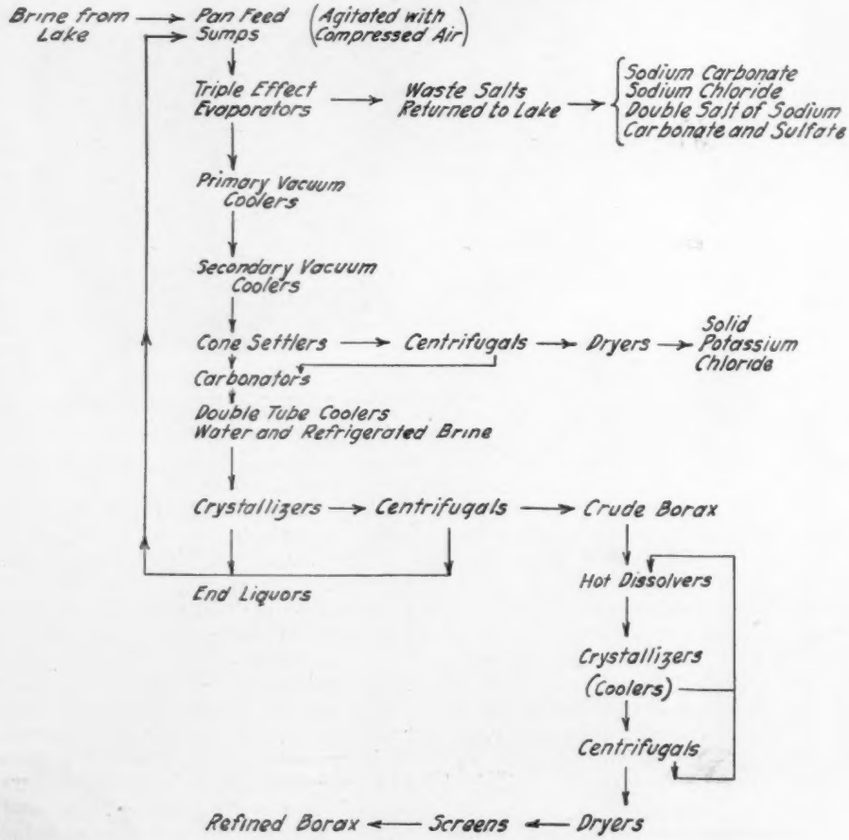
Top, left—The great cooling towers, built of redwood, that lower the temperature of the water used in the evaporating units of the plant. Right—The plant at Trona viewed from the north and rear. Bottom, left—One of the fourscore Cameron centrifugal pumps that keep the liquids moving throughout the plant. Right—Air-driven tools have plenty to do in upkeep and reconstruction work about the plant.



Left—Near view of part of the evaporator house. Top—Plant office. Bottom—General view of the plant from the south and east.

peculiar to the environment in which the plant is set. One by one, each puzzling problem has been solved; and this outcome is not only the consequence of resourcefulness on the part of the engineering staff but is also due in large part to the loyalty of everyone concerned.

Perhaps a still better idea of what takes place in the plant at Trona can be had if we mention that 1 ton of brine holds in solution but 95 pounds of muriate of potash and 30.2 pounds of anhydrous borax. Furthermore, each ton of brine is made up of 1,304.4 pounds of water. Therefore, the vacuum pans must handle nearly 21 tons of brine to produce a single ton of potash, and the 2,000 pounds of potash must be separated from 12,400 pounds of other salts! The market value of the superior products obtained at Trona justifies the expense involved in the whole cycle of operations. It has been authoritatively estimated that Searles Lake contains in the neighborhood of 35,000,000 tons of potassium chloride—enough to meet our agricultural demands for a century at the present rate of consumption. Big as the plant at Trona is, it is able to turn out in the course of a twelvemonth only 80,000 tons of potash, figured as pure KC1.



Flow sheet of plant operation.

Inasmuch as substantially 200,000 gallons of liquid is delivered by pumps every minute to essential apparatus through miles and miles of piping, it should be plain that the pumps have a prime part to perform in maintaining the flow in this expansive circulatory system, which extends from the brine wells in the lake to the points where waste or end-liquors are discharged for return to the lake. These pumps must handle the brine throughout a wide range of temperatures and diversified degrees of concentration—in short, perform an exacting service and meet operating conditions that would soon incapacitate pumps of types not combining excellence of design with superior materials and workmanship. At Trona, this essential distribution of liquids is effected by no fewer than fourscore Cameron centrifugal pumps, of various sizes and kinds, manufactured by the Ingersoll-Rand Company. Experience has proved the wisdom of this standardization.

Perhaps it will help to a fuller understanding of what the plant at Trona represents if we summarize the outstanding features in tabular form:

Steam plant	7,000 hp.
Electric power used	2,500 kw.
Electric power generated at Trona	2,000 kw.
Refrigerating plant, capacity	600 tons
Evaporator plant, water evaporated per day	4,200 tons
Production of potassium chloride per day	225 tons
Production of borax per day	125 tons
Men employed	580

The Trona plant has associated with it an industrial community well provided with conveniences and means of diversion for the well-being and the pleasure of the people necessarily segregated in that out-of-the-way section of the Mohave Desert. Drinking water is drawn through 30 miles of piping that leads to sources in three different canyons back in the Argus Mountains. This water is soft and free of alkali. About six miles north of Trona, in the valley, are a number of wells from which is obtained an ample supply of water that is slightly saline in character. This water is used for cooling and condensing purposes in the plant, and for sprinkling the grass, the flowers, and the trees that otherwise would not survive in that region.

The American Potash & Chemical Corporation maintains a general store which is run upon a profit-rebating basis; and all sales are for cash. In the course of a single day business

is done to the value of more than $1,000. During a period of three and a half years, for example, more than 10 per cent of the money spent by employees in the store was returned to them in the form of a rebate; and this was done despite two substantial reductions in retail prices. This store operates a lunch counter where short-order meals may be obtained from 6.30 a.m. to 9 p.m.

The corporation has nearly 100 dwellings for the use of employees desiring to have their families with them. In addition, there are quarters for single men, a guest house, and a number of bunk houses. Trona boasts a library, a movie theater, and a community club. The club is an effective medium in promoting friendly relations and unity of interest in the general welfare of the residents. At the Valley Wells there is a regulating reservoir 125 feet wide and 225 feet long. The inner faces of the enveloping walls of concrete are so sloped that this reservoir can safely be used as a swimming pool, and to this end bath houses have been erected for the convenience of the personnel. In the surrounding grove are picnic tables, camp stoves, etc; and on warm evenings many of the workers of Trona gather there for diversion and refreshment. Indeed, the company does everything possible to make its employees happy and permanent in their service—substantial bonuses being the reward for work well done and attention to the company's interests.

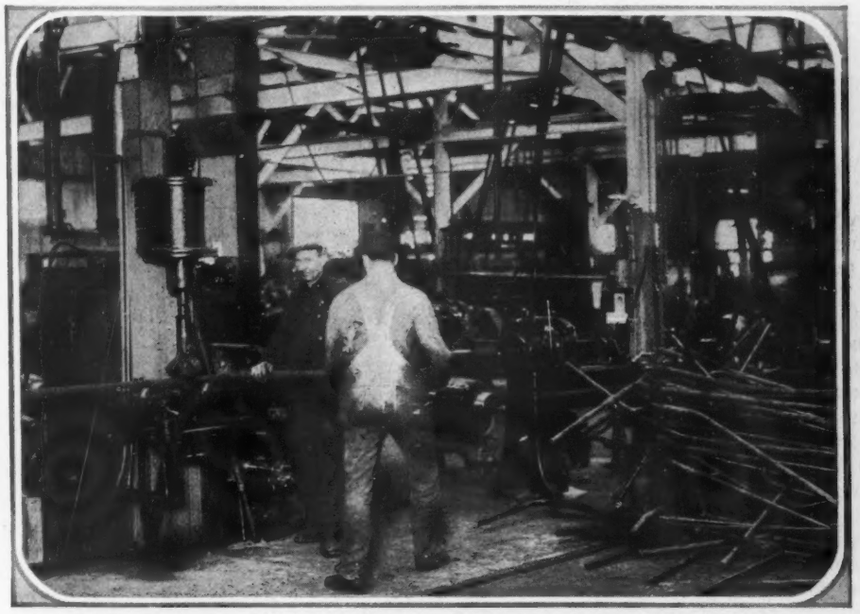
Trona is a monument to engineering skill and chemical cunning of a high order, and it is also impressive evidence of courage and of exemplary patience on the part of those who supplied the money to finance this ambitious undertaking, in the desert, primarily intended as an aid to the American farmer.

COAL-CLEANING METHODS STUDIED

IN a paper presented to the American Iron and Steel Institute by Mr. William A. Forbes, assistant to the president of the United States Steel Corporation, he has this to say on the subject of cleaning coal:

Comprehensive studies of the various coal-cleaning methods have been conducted, and actual tests of coal from many fields have been made on the various equipment for mechanical cleaning, including the wet, dry, and pneumatic processes. All principles for the reduction of impurities in coal are based upon differences in specific gravity between clean coal and impurities. The most successful plans for improving the quality of coal are based upon the flotation method of employing the difference in specific gravity. Of these, in large-scale operations, water flotation and air flotation are the two which have so far met with the greatest success.

With the production in 1927 of minerals valued at $241,773,000, as compared with $240,437,000 in 1926, the mining industry of Canada has made another record, according to S. J. Cook of the Dominion Bureau of Statistics. This puts Canada fourth in the list of the world's foremost mining countries.



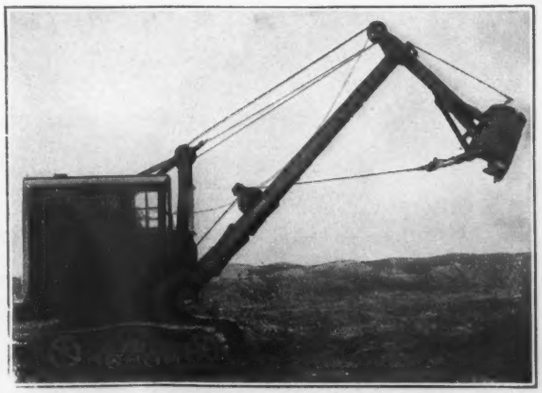
One of the many ways in which compressed air is used in the San Francisco shops of a street-railway company. Here a pneumatic brake cylinder has been transformed into a pipe-bending machine.

EIGHT MACHINES IN ONE

IN response to a demand for trench hoes and skimmer scoops, the ½-yard excavator of the Harnischfeger Corporation is now convertible, like its other four models, for use as a shovel, dragline, clamshell, pile driver, trench hoe, skimmer scoop, etc. This is effected by simply changing booms.

To substitute one attachment for another it is not necessary to remove the power drum, to which a special spider is permanently secured. The lagging required for the various classes of work is split in two sections, and can be quickly bolted to the drum spider. In this way all the wear is on the inexpensive lagging and not on the drum.

According to the manufacturer, the hoe for the ½-yard excavator can dig to a depth of 16 feet; and by shifting the course of the boom and the bucket any width of trench within the machine's limits can be dug. The skimmer bucket has a horizontal travel of 13 feet. Heavy spring bumpers are cast integral with the boom foot, thus preventing the heavy jolts otherwise imparted to the boom when the bucket rolls back to the excavator. The hoe and skimmer booms are built up of strong I-beams securely trussed and braced.



The field of service of this excavator has been increased by making its boom changeable.

USE OF COMPRESSED AIR IN THE SAWMILL

THE application of compressed air in the lumber industry is steadily expanding. As proof of this let us cite the case of a large sawmill on the Pacific coast where two compressors are in service. Each of these machines has a capacity of 1,570 cubic feet at 125 pounds pressure; and they furnish air to operate the following equipment:

Five saw carriages complete, including set works and dogs; bumpers on ends of saw carriages; all trimmers; controllers in dry kilns and on steam superheaters; automatic damper controllers on boilers; air drills and hammers; and signal "howlers", as well as whistles on the fire-alarm system. Besides, it is utilized for pumping water from pits, for maintaining pressure on dry-sprinkler systems, for cleaning machinery, and for sweeping floors and other parts of the mill and associate buildings. In commenting on the use of compressed air in the plant in question, the engineer made the statement that many other applications for this motive medium would in all likelihood be found in the future.

There are in operation in Canada about 500 coal mines, representing a capital investment of approximately $150,000,000.

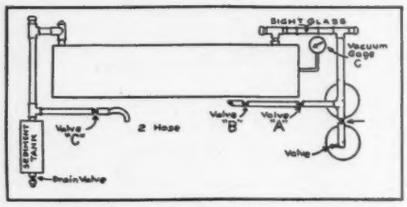
Portable Compressor Clears Service Lines in City Gas System

TO the gas-consuming public it may not be common knowledge that the industry which supplied the nation with 475,000,000,000 cubic feet of gas in 1927 had its beginning in this country just 111 years ago, that is in 1817, when the Gas Light Company of Baltimore was incorporated. What has been done since then in upbuilding the industry, can, perhaps, be made still plainer by giving a few more figures. Manufactured-gas companies now serve 11,400,000 customers, to whom gas is delivered through 91,000 miles of mains—91,000 miles of underground piping carrying fuel for cooking, heating, lighting, and various industrial purposes to homes, shops, factories, etc. The task of maintaining uninterrupted service throughout this vast network of independent lines has not been the least of the problems that have been engaging the attention of gas companies.

Until recently, no satisfactory equipment was available that could be counted upon quickly and effectually to clean out obstructed service lines—that is, the piping leading from the supply mains into consumers' homes or places of business. In the past, according to the Illinois Power & Light Corporation, of East St. Louis, Ill., whenever there came a call, "There is something the matter with our gas", out would go the emergency wagon with the bell pump to clear the blocked service line. This happened most frequently in the older sections of the city.

In the majority of cases, the trouble was found to be of a minor character, requiring the adjusting of appliances. In other instances, however, there were stoppages. Then the "troubleman" would be compelled to bring the bell pump into play and to free the passages by blowing condensation and other foreign matter back into the distributing system. This he effected by disconnecting the meter at the inlet side and by attaching the pump to the service inlet.

But this method offered only temporary relief, as the same material—especially if in the form of naphthalene, iron scale, or dirt—would again be picked up in the supply main and deposited elsewhere. In short, it just meant more trouble for the company in the shape of another service call. That was the situation when M. R. Noack, the manager of the Illinois Power & Light Corporation, and C. R. Grine, the superintendent of distribution of that company, succeeded in devising an outfit that makes it possible to remove such clogging masses from service lines.



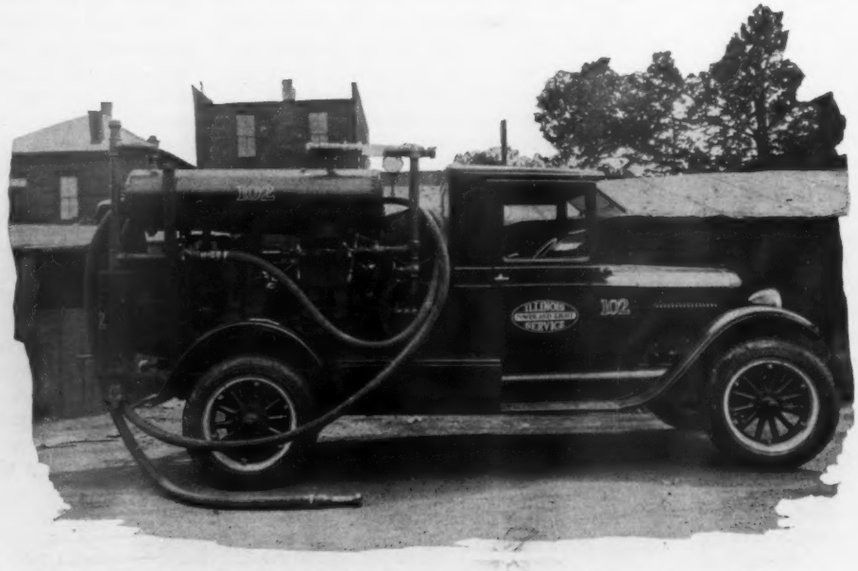
A, valve to vacuum tank; B, valve to atmospheric intake; and C, valve to house service line.

The equipment in question consists of a 5½x5-inch Type 20, portable compressor, manufactured by the Ingersoll-Rand Company, modified to meet the particular needs of the distribution department. This unit is driven by a gas engine, is mounted on a 1-ton Chevrolet truck, and is equipped with a vacuum tank and a sediment tank. It will be seen in the accompanying diagram that the line leading from the pressure tank to the vacuum tank is connected by means of a piece of 2-inch piping with a 2-inch glass tube, which is provided for observation purposes. In this sight glass is placed a damp sponge to catch and to hold any fine particles of dust, and thus to prevent them from getting into the compressor. Copper screens are fitted into the tees as an added safeguard against dirt or foreign substances. That these precautionary measures are entirely adequate has been proved by the fact that this outfit—when not engaged in cleaning out service lines—has been used to drive pneumatic tools in repairing gas holders. This has called for air at 90 pounds pressure. This pressure the portable has maintained without difficulty—an indication that no foreign matter has succeeded in filtering through the sponge and the screens into the compressor.

In doing the class of work for which the portable was designed, the compressor is made temporarily to act as a vacuum pump; and valves are provided that will close the air-intake line and hook the compressor directly with the vacuum tank. A vacuum of 27 inches can thus be created in the tank. This tank, when connected with the house line, serves to induce a suction on the obstruction in the line and to draw the blocking material into the sediment tank that is interposed in the system for that purpose.

The cycle of operations is as follows: After the compressor is started up, valves A and C—as indicated in the accompanying drawing—are closed and valve B allowed to be open to the atmosphere. Then, to create the vacuum, valve A is opened and valve B is closed. With this done, valve A is closed and valve B opened simultaneously. Everything is now in readiness, and it is only necessary to open valve C to clean the service line.

The equipment has now been in use for months; and, to quote *Current Topics*—the official organ of the Illinois Power & Light Corporation—"the machine has paid for itself many times over in rendering better public service."



This modified portable serves either as a vacuum pump or a compressor, depending on whether it is called out to clean a gas service line or to do repair work requiring the use of pneumatic tools.

According to advices from Ottawa, the Canadian seat of Government, Montreal is to become the center of air-mail distribution for eastern Canada—experiments in the transfer of mail from and to ocean liners having proved entirely practicable. The next step in the program of aerial transportation is to connect Montreal with the large cities both in the United States and in Canada lying within a radius of several hundred miles of that port. It is also reported that Halifax business interests are contemplating an air line for freight, express, and mail between Halifax and New York City.

The eighteen provinces that compose China proper cover an area of 981,000,000 acres, or a little more than half the area of the United States.

Oil-Engine Compressors Furnish All Power at Old Congreso Mine

This Historic Mine, in Mexico, Was First Worked in the Days of the Spanish Conquistadors

By J. H. ROEBUCK

CONGRESO Mine, located at San Pedro, Chihuahua, is one of the old mines in Mexico; and for several years it was in a state of idleness. Before closing down in 1913, this gold-silver-lead mine was operated by the Candelaria Mining Company. Today the mine is leased by the Compania Minera de Penoles, S. A., which is a subsidiary of The American Metal Company, Ltd. Considerable work is now being done at this unit in prospecting old workings and in developing new ore bodies.

The first-known workings of this mine date back to the days of the early Spaniards: and about 1621 Cordova camped four miles from the present site of San Pedro. It is very probable that this part of the country previously had been prospected by the Indians. Cordova found ore on the west slope of San Pedro Mountain, and there built a smelter. Some years later, a larger smelter was erected 30 miles away on the banks of the Rio Corralitos. The ruins of this smelter are still standing. It is reported that miners of this section rejected ore when it contained values totaling less than $10 a pound. Near the site of the smelter, the Indians excavated an amphitheater in the rock of a hillside; and when the surface was worked out nothing was done in depth.

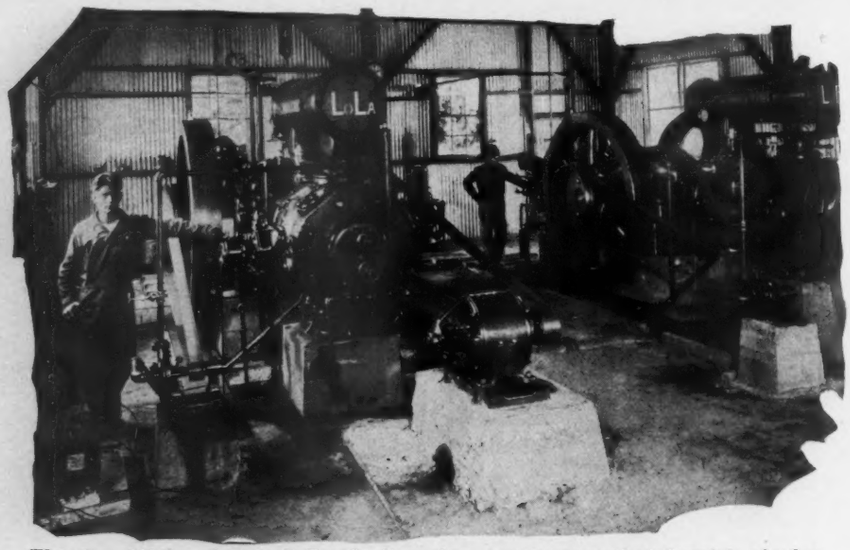
POWER plants in regions remote from railroads or other convenient means of transportation present troublesome problems ordinarily. This is especially true where fuel has to be hauled a long distance, thereby materially increasing operating costs when everything must be done to keep these costs low.

In earlier issues we have called attention to the advantages of the portable compressor, using gasoline, as a source of power in isolated mining regions. The present article focuses attention upon the still greater economies that can be realized by utilizing oil-engine-driven compressors—fuel oil being notably cheaper than gasoline.

Americans entered the region in the nineteenth century and worked throughout a large area down to the water level. Coming along to the beginning of the twentieth century we find that the Candelaria Mining Company installed a 200-gallon pumping plant in the Congreso Mine in 1904. Five years later, that company was pumping 3,000 gallons of water a minute, and was shipping six cars of ore daily. During 1911 the Candelaria Mining Company was engaged in erecting two 3,000-gallon-per-minute station pumps which, together with the two old 1,500-gallon-per-minute pumps, were counted upon to give a capacity of 9,000 gallons per minute. This latter work was not completed.

That same year an air lift was provided capable of handling 2,000,000 gallons of water per day. This installation consisted of a 12-inch casing; and air was supplied by a 2,700-foot compressor. To lower the water level re-

This partial panoramic view of the surface workings and the camp of the Congreso Mine gives a good idea of the barrenness of the region.



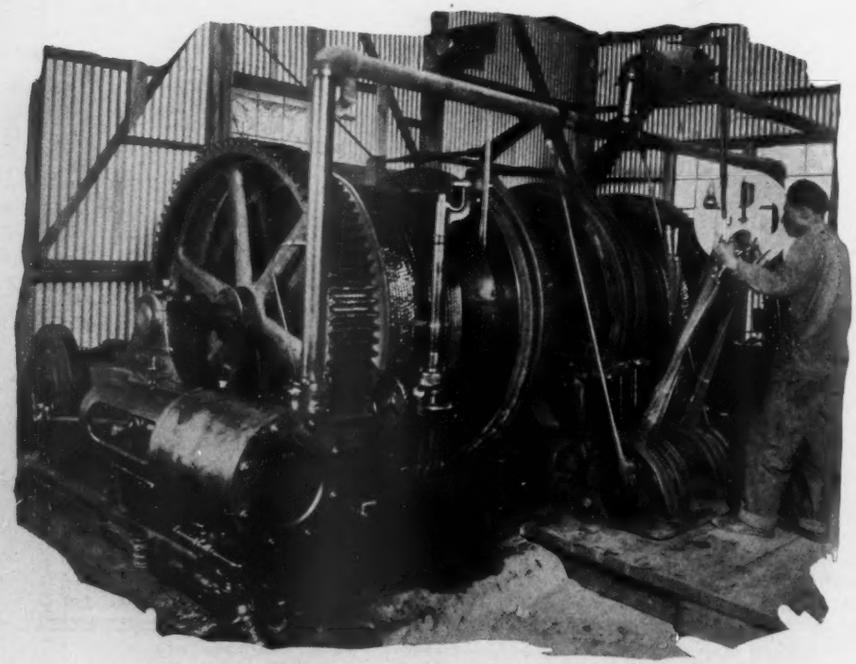
The two 110-hp. Ingersoll-Rand oil-engine compressors that furnish air for different purposes at the Congreso Mine, San Pedro, Mexico.

quired the pumping of 15,000,000 gallons of water per foot of depth. Before pumping started, the water level was 275 feet from the outcropping of the vein.

Three 6-inch, 4-stage centrifugal sinkers formed another interesting part of the old equipment. These pumps were driven by direct-connected turbines of 200 hp.—which ran at the rate of 2,000 revolutions per minute—and had a capacity of 1,000 gallons per minute at a head of 500 feet. When one sees the size of these sinkers one marvels at the nerve of the men that tackled this pumping problem.

During the years following, revolutionary disturbances occurred; and in 1911, owing to the fact that the railroad had been severed. it was no longer possible to get coal to the mine. Accordingly, the mine was entirely closed down early in 1913. While the country was upset by the revolution, the outside workings of the mine were almost completely destroyed.

In the beginning of 1926, the Compania Minera de Penoles, S. A., took an option on the property; and, after a four months' examination, leased it. When the engineers of that company came to the point where it was necessary to select a power plant to work the mine, they decided to install a number of Ingersoll-Rand direct-connected oil-engine compressors. They reached this decision because of the excellent performance of similar units of the same make already owned and used elsewhere by the Compania Minera de Penoles. They also planned to recondition the old steam hoist, which was left on the property, so that it could be operated with air. This is a double-drum hoist that has 12x14-inch cylinders.



This double-drum hoist is operated with compressed air.

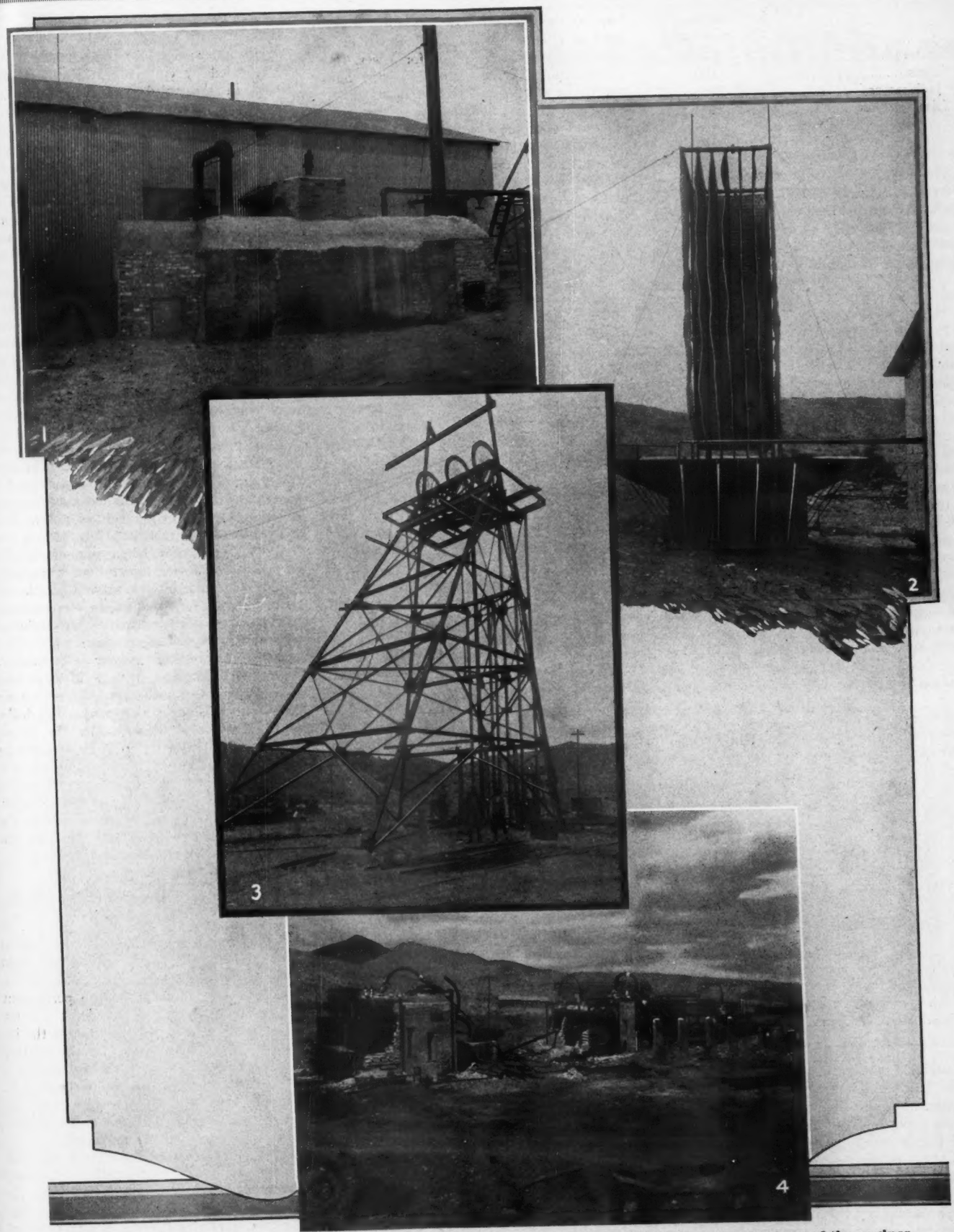
The two 110-hp. POC units now in service there are at an altitude of 5,000 feet above sea level; and the capacity of the compressors was reduced to allow for the decrease in horsepower rating so that the oil engines would be loaded at 90 hp. each. Hand-operated clearance pockets were placed in the compressor cylinder head of each machine to permit a further reduction in capacity in order to take care of a 10-kw., 110-volt, direct-current generator, which is belt-driven from a pulley bolted to the flywheel. This generator furnishes current for lights and for running a small triplex pump which requires 3 hp. This pump lifts approximately 5 gallons per minute about 450 feet from the mine to a storage tank which supplies the make-up water for the cooling systems of the engines, as well as water for the mess hall and houses.

An old boiler was adapted for use as an air receiver. This boiler has a diameter of 5 feet 6½ inches and a length of 14 feet. It is about four times the size of the receiver that would ordinarily be provided for compressors of the capacity of those in question. There is an additional small receiver on the fifth level of the mine. The boiler receiver is so arranged that the exhaust from one of the engines passes through the tubes. This exhaust serves to heat the air and to increase the efficiency of the hoist, incidentally preventing the exhaust of the hoist from freezing. During the summer months it was not found necessary to jacket the receiver, but it has since been completely jacketed—as shown in one of the illustrations—so as to utilize more of the heat from the engine exhaust.

The cooling system for the oil-engine compressors consists of a square tank holding 1,300 gallons of water. On this tank are mounted vertically, on a pipe frame 5 feet wide by 26 feet high, screens of ½-inch mesh. When the outside temperature is between 90 and 100° F. about 21 gallons of water are evaporated hourly, and when the temperature is from 50 to 70° F. about 3 gallons of water are evaporated hourly. Approximately 30 gallons a minute are circulated through the two units.

The average load that the hoist raises to the surface is 1,605 pounds, and the average time to lift the load a distance of 350 feet is one minute. Indicating the cylinders of the hoist, and referring back to the oil engine while hoisting, a demand of 90 hp. is made upon the engine. However, the hoist never operates longer than one minute out of four, so that the average demand of the hoist upon the oil engine is not more than 22½ hp. It is for this reason that it is advantageous to use air for hoisting; and additional gains lie in the resultant very smooth functioning and in the lower initial investment. If the hoist were operated by electricity it would require a 50-hp. motor and a 65-hp. generator plant, which would run at no load for at least three-fourths of the time.

Besides the hoist, the following drills are air driven:



1—Air receiver, made of a fire-tube boiler, in which the compressed air is heated by the exhaust of one of the engines. This increases the effectiveness of the air and prevents the exhaust of the hoist from freezing. 2—Tower that cools the circulating water for the oil engine-compressor units. 3—Headframe at the Congreso Mine. At the left in the foreground is Mr. Roy A. Mathewson, superintendent of the property. 4—Ruins of old steam-power plant, destroyed during the Villa revolution.

	Air Consumption Cu. ft. per min.
2 Drifters	340
2 Stopers	100
3 "Jackhamers"	240
2 Diamond drills	300
	980

The capacity of the two compressors is 850 cubic feet of air actually delivered. Needless to say, all the foregoing equipment is not working at the same time; but an 850-cubic-foot compressor installation would not be considered over large for this plant. Therefore, by the use of a large receiver, the company is able to do its hoisting without an additional initial investment for power.

In keeping the cost records of the power plant, the starting and the stopping time of each unit is accurately noted. One unit is operated continuously, while the other one is started and stopped about twice a shift as the load falls off or increases. However, no records are made of the time the compressors run unloaded—the costs being figured on the basis of a constant load of 90 hp. each. The plant was started on May 15, 1927, and since then has been operating continuously two shifts a day.

Cost Records for August and September, 1927

	August	September
Fuel oil, gals	2,338	1,753.5
Running hours Unit No. 1	187.5	213.5
Running hours Unit No. 2	491.5	421.5
Total running hours Units Nos. 1 and 2	679	635
Fuel oil per hour, gals	3.44	2.76
Fuel oil per brake-horsepower-hour, gals	0.038	0.03
Fuel oil per brake-horsepower-hour, lbs	0.289	0.228
Weight per gallon of fuel oil, lbs	7.612	7.612
(The foregoing figures are based on 90 hp. continuous load rating.)		
Lubricating oil for oil engine, gals	35	25
Lubricating oil for compressor, gals	10	10
Gasoline for starting unit, gals	10	10
Cost fuel oil, in pesos	342.46	256.85
Cost supplies—lubricating oil, gasoline. waste, grease	194.94	87.00
Labor	294.81	200.00
Special maintenance labor	14.00	144.19
Total cost, in pesos	846.21	688.04
Total horsepower-hours	61,110	57,150
Power cost per horsepower-hour, in centavos	1.4	1.20
Power cost per horsepower-hour on a 2-1 exchange basis	7/10c	6/10c

Distribution of Power

	—August—			—September—		
	Hp-Hrs	Per Cent	Pesos	Hp-Hrs	Per Cent	Pesos
Air	58,350	95.5	808.13	55,868	97.7	672.22
Light	430	.7	5.92	282	0.5	3.44
Pumps	2,330	3.8	32.16	1,000	1.8	12.38

Cost Per Gallon at Mine

	Mexican Currency	U. S. Currency
Fuel oil	$0.146	$0.073
Lubricating oil for oil engine	1.85	0.98
Lubricating oil for compressor	1.74	0.87
Gasoline	0.64	0.32

An aerial ropeway that will be 105 miles long is now in course of construction in Colombia, where this mode of transportation is largely depended upon to get raw products out of the interior. This conveyor extends from Cucuta to the Port of Gamarra, on the Magdalena River. The cable will have a capacity of 20 tons an hour in both directions. and the rate of speed will be 18 miles an hour. Another even longer aerial ropeway has been planned, and this is to connect Manizales with El Choco, 115 miles away.

In making ship propellers considerable labor is involved in smoothing the driving sides of the blades. If they are rough, says *Iron Trade Review*, power is expended needlessly to overcome the resistance set up by friction. Propellers for large liners, for example, are first machine-planed accurately to pitch on the driving surfaces, at which time they also receive their over-all finish. Part of this work is done with pneumatic chipping hammers, followed by hand filing and rubbing with abrasive cloth.

PROMISING POTASH FIND

THE thickest bodies of potash salts yet revealed by Government tests have been found in the third well drilled in Eddy County, New Mexico, according to a statement made public by the United States Department of the Interior. The Geological Survey has recently completed analyses of samples selected from the core of this well, and these show that within 1,500 feet of the surface nine beds or groups of beds of possible commercial value were encountered. One of these, at a depth of about 1,466 feet, is 8 feet 10 inches thick and contains 11.08 per cent of potash (K_2O) in the sample as received, which is equivalent to 18.25 per cent K_2O in the soluble salts. Other noteworthy beds range in thickness down to 2 feet 3 inches, and in potash content from 8.50 to 13.68 per cent in the samples as received. The samples analyzed came from depths ranging all the way from 365 feet 10 inches to 1,475 feet 4 inches.

Only one potash mineral, polyhalite, was recognized in the samples recovered in drilling, but owing to difficulties experienced in this connection some of the more soluble salts originally present may have been lost.

Because of its relatively low potash content—15.6 per cent when pure—polyhalite is not as desirable a mineral for commercial purposes as carnallite or sylvite, which contain relatively larger amounts of potassium. Nevertheless, it is not to be disregarded as a source of commercial potash.

Well No. 3 is about eleven miles south of the McNutt location, in New Mexico, from whence the first potash core was taken a few years ago. It is one of the group being drilled by the Bureau of Mines under the potash act, which provides for joint exploration by the Geological Survey, representing the Department of the Interior, and the Bureau of Mines, representing the Department of Commerce. The Geological Survey selects the drilling sites and receives and analyzes the cores obtained by the Bureau of Mines.

AIR-OPERATED EXTENDABLE STATION PLATFORM

AT the Wood Green Station of the Central London Railway there has recently been put to use a movable platform that serves, when necessary, to lengthen the permanent platform alongside the main tracks. When need arose for longer trains to handle the increased traffic, it was found that the existing platform could not be extended because of a sharp curve at the approach end of the station. A wooden structure has therefore been devised that can be swung into place, as desired, to accommodate either of the trackways.

This platform turns about a pivot near the tangent point of the curve, and is supported by wheels running on sector-shaped rails. It is moved in and out of position by a pneumatic cylinder; and its operating gear is interconnected with the signal system so that there is no danger of an incoming train striking the protruding end of the revolving platform.

Portables Save Money at Isolated Mines in Clericy District of Quebec

IN the Clericy District, of Quebec, some distance removed from railhead, the Harvie Mining Company has four showings, known as the Harvie Archean Mines. and at three of them operating plants are in service. The associate camps are a mile or more apart—Showing No. 1 being the closest to the base camp, about a mile and a half away. Coal costs $12.50 a ton at railhead; and to reach the mining property it has to be hauled a matter of approximately eight miles, adding just so much to the ultimate cost of the fuel. Under these circumstances, fuel for power purposes is an item of outstanding importance in the successful exploitation of the property. The situation has been effectively met by the employment of a number of portable compressors, suitably housed and serving as primary sources of power. These compressors use gasoline for fuel, and this is purchased in drums and landed at the base camp which is about three miles from the farthest plant. The gasoline costs 42 cents a gallon.

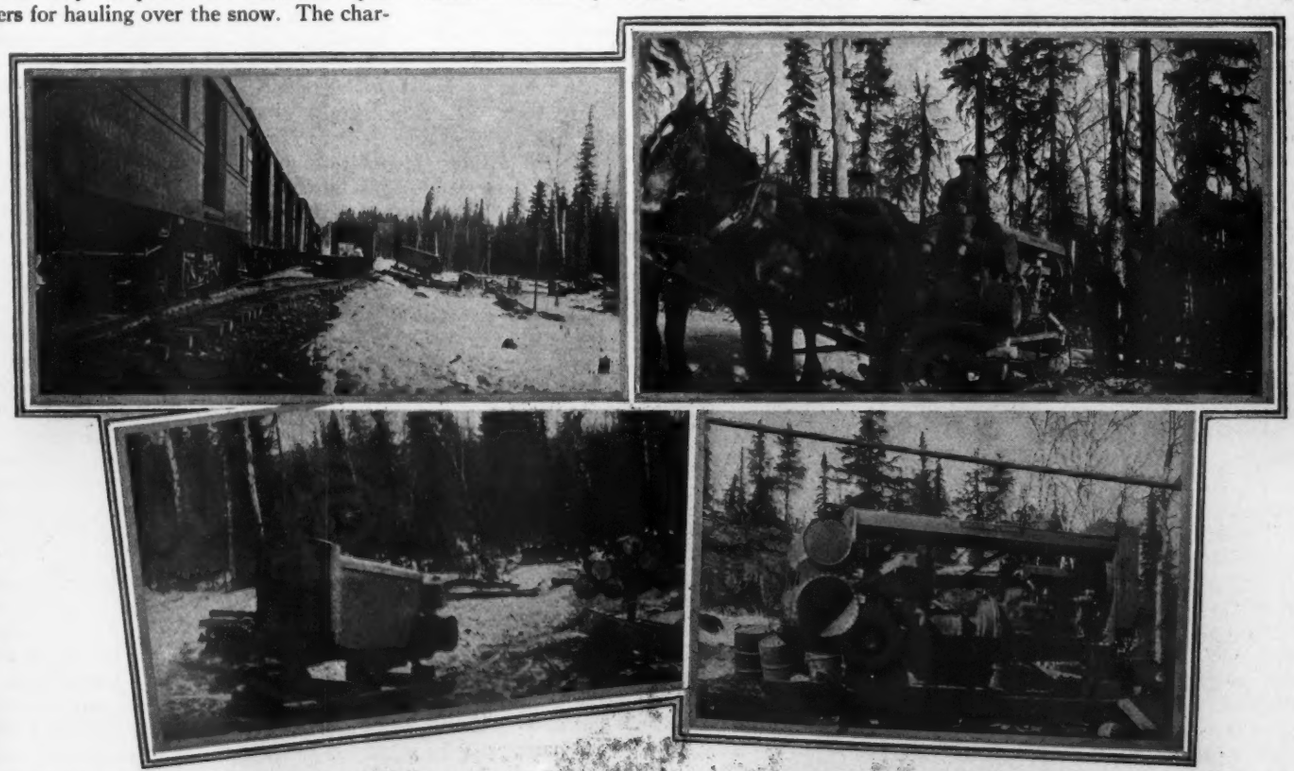
Some of the accompanying photographs illustrate the manner in which the portable compressors were moved from railhead to their respective permanent stations at the different showings or camps. As can be seen. the portables were dismounted from their wheels and secured, instead, upon skids that made it easy to place the machines upon runners for hauling over the snow. The character of the structures used to house the portables at the mines, is also indicated by certain of the pictures.

The following particulars regarding the equipment and the activities at the several camps have been furnished by a representative of the Harvie Mining Company. At Showing No. 1, the plant is made up of two 9x8-inch Type 20 portable compressors, one 6x8-inch Jenckes steam hoist, two R-72 wet drifting drills, and one Ventube ventilator for removing powder gases underground. The plant is operated on two shifts a day. When using but one of the drifters for a little more than two hours and working at two faces an advance of 9 feet has been made in 24 hours—air being furnished by one of the compressors. With the setting up of the second portable the two drifters were put to work, doubling the footage by making it possible to drill at four faces.

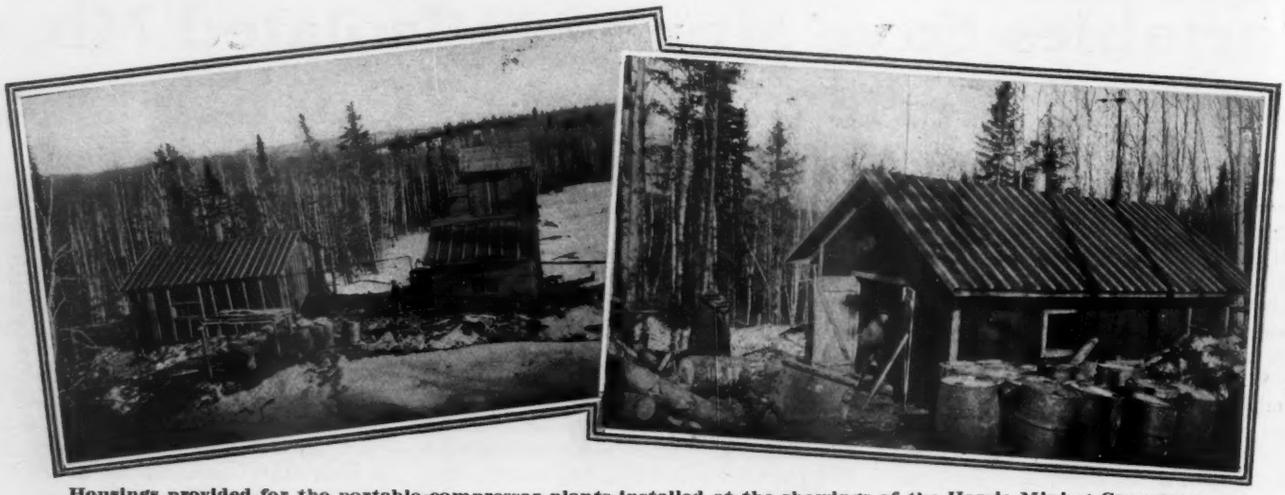
The Ventube is a small steam turbine. direct connected to an evacuator which withdraws the powder gases from the face of the drift and discharges them through canvas tubing. The apparatus has been operated with compressed air, and has virtually required all the air that could be supplied by one of the 9x8-inch portables. The Ventube has been able to remove the gases in 25 minutes where previously it took several hours to do this by releasing compressed air at the face. The Jenckes steam hoist has been run with steam or compressed air, depending upon the amount of air available at the time.

The two portables have been hooked up so that their two receivers discharge into a common header leading to a large receiver placed outside the compressor house. The cost per shift for running each unit has been $1.47 an hour, including gasoline and lubricating oil. To this should be added wages for the operator at the rate of $5.60 a day, making a total daily operating outlay of $17.36. When both compressors are run simultaneously the cost per shift is only $29.12, because a single attendant can take care of both machines. Drill steel is bought made up and sharpened by hand on the job. Drill costs have been very low.

At Showing No. 2, the plant comprises one 7x6-inch Type 20 portable compressor, one R-72 wet drifting drill, and one Ventube. At the time of writing, the development at this camp consisted of an adit driven into the side of a hill so that it was not necessary to install a hoist. The adit was then in a distance of more than 600 feet, and the compressor was able to furnish air at a sustained pressure of 80 pounds per square inch—the R-72 performing well. As has been the case at Showing No. 1, the Ventube pulled down the pres-



Top, left—Unloading a portable compressor at railhead, eight miles away from the Harvie Archean Mines. Right—Portable, mounted on runners, being hauled over the snow from the railroad to the mining property. Bottom, left—Portable landed at one of the showings preparatory to being shifted to its permanent position. Right—One of the units in place and ready to be housed over.



Housings provided for the portable-compressor plants installed at the showings of the Harvie Mining Company in the Clericy District of Quebec.

sure whenever it was necessary to use it for evacuating the powder gases. The R-72 drill advanced the face about 5 feet a shift. The cost of operating the compressor, which was then only one and a half years old, was $8.40 for gasoline and lubricating oil and $5 for an attendant, making a total of $13.40 a shift, or an average rate of $1.05 per hour.

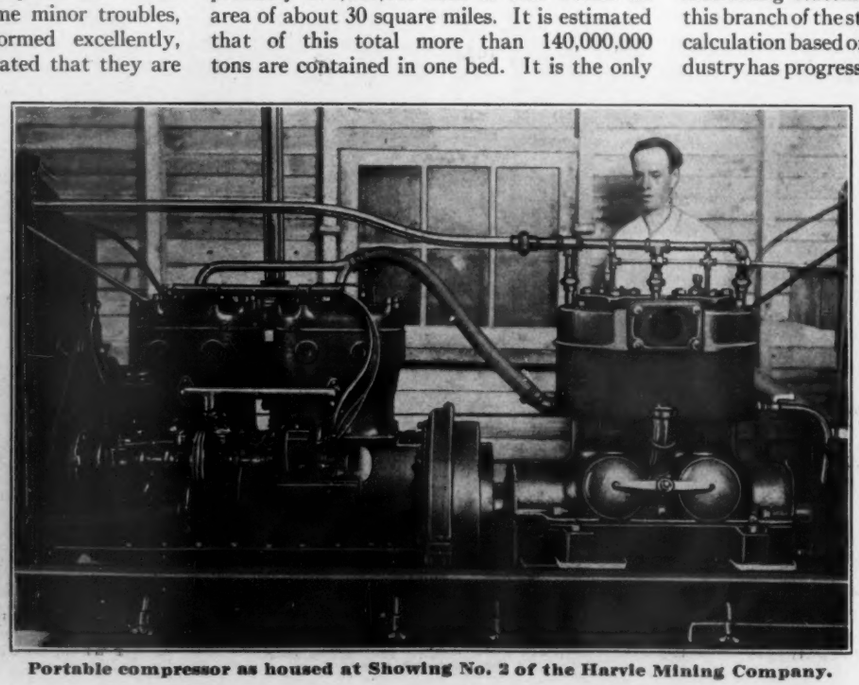
The plant at Showing No. 4 is made up of one 5½x5-inch Type 20 portable compressor, one Novo gasoline hoist, and two DCR-34 "Jackhamers". The shaft at this point was sunk to a depth of about 80 feet with one of the "Jackhamers" driven with air furnished by the foregoing compressor. The second "Jackhamer" was held as a spare. The compressor was run two shifts daily, and maintained a line pressure of 70 pounds per square inch. Operating costs averaged 65 cents an hour for gasoline and lubricating oil, with a charge of $5 a day for the attendant—bringing the total outlay to $10.20 per 8-hour shift. With the exception of some minor troubles, the portables have performed excellently, and have amply demonstrated that they are valuable sources of relatively low-priced power, especially when set up in places more or less remote from railhead and where fuel for steam raising is high. In using the internal-combustion engine, as is the case with the portable compressor, it is possible to avoid the stand-by losses inseparable from a steam-operated plant. The gasoline engine consumes fuel only when actually running; and it may be started instantly whenever desired. These facts help to make it clear why these prime movers have been so satisfactory in their work in the Clericy District.

EXTENSIVE COAL MEASURES FOUND IN UTAH

SINCE the settlement of the central part of Utah, about 1850, the thin beds of bituminous coal that crop out along the sides of Salina Canyon have been mined intermittently in a small way to supply the domestic needs of local residents—the showings not having proved sufficient to encourage large-scale mining. But latterly, we are told by the United States Department of the Interior, with the discovery of enormous reserves of high-grade coal on the east face of the Wasatch Plateau, prospectors have become interested in the region. Recently a mine was opened at the head of Salina Canyon; and it is expected that coal will soon be produced there on a commercial scale.

An examination of the district by Government geologists has revealed the presence of probably 170,000,000 tons of coal within an area of about 30 square miles. It is estimated that of this total more than 140,000,000 tons are contained in one bed. It is the only exposed coal bed in the section worthy of consideration for large-scale development, although further diamond drilling may lead to the discovery of other thick and underlying beds.

The coal is a good grade of bituminous. It is hard, black, and lustrous; and its stocking qualities are satisfactory. Lumps of the coal that had lain on a mine dump for many months were found to be little affected by the weather. On the basis of the present estimates of the amount of workable coal, the field has many advantages to offer in favor of its development. It is conveniently located in respect to the existing coal markets of the West; and, besides, there will be a market for the product in the adjacent valleys where numerous beet-sugar mills and mines are in operation.



Portable compressor as housed at Showing No. 2 of the Harvie Mining Company.

The vice-president of the Vanadium Corporation of America, in a recent address on the subject of alloy steels, made the following interesting statement on the development of this branch of the steel industry. According to a calculation based on statistics, the alloy-steel industry has progressed eighteen times as rapidly within a period of fifteen years as the general steel industry, whose growth might be considered phenomenal. Alloy steels have entered fields where their application could hardly have been prophesied and are, as a result largely responsible for present-day engineering advancement.

At the recent annual convention of the Associated General Contractors of America, held in West Baden, Ind., the opinion was expressed that more than 3 000,000 workmen would be employed this year in the construction industry in the United States.

Bellingham's Coal Mine a Busy One

From this Source the State of Washington Obtains Much Excellent Sub-Bituminous Coal

By C. W. BUCKLEW

THE State of Washington produced from its own mines in 1925—the latest period for which statistics are available—a total of 2,537,890 tons of coal. This fact should be of general interest, because most people in the United States are unaware that Washington is self-sufficient to this extent in the matter of fuel of this sort.

The Bellingham Coal Mines are conspicuous by reason of the part they play in contributing substantially to the foregoing output; and this enterprising concern has in its Mine No. 1 what is said to be the largest strictly commercial colliery in the state—producing an average of 1,300 tons of sub-bituminous coal in the course of every 8-hour working day.

Mine No. 1 lies in Whatcom County in the extreme northwestern section of the nation, and is within the municipal limits of the City of Bellingham. The mine is at a point about 1½ miles from tidewater; and its lowest workings have penetrated to a depth of more than 710 feet below tide level, or 803 feet below the surface of the ground at the pit mouth. Notwithstanding that the mine is thus comparatively close to Bellingham Bay, still it is notably dry, and not more than 150 gallons of water a minute have to be removed by pumping.

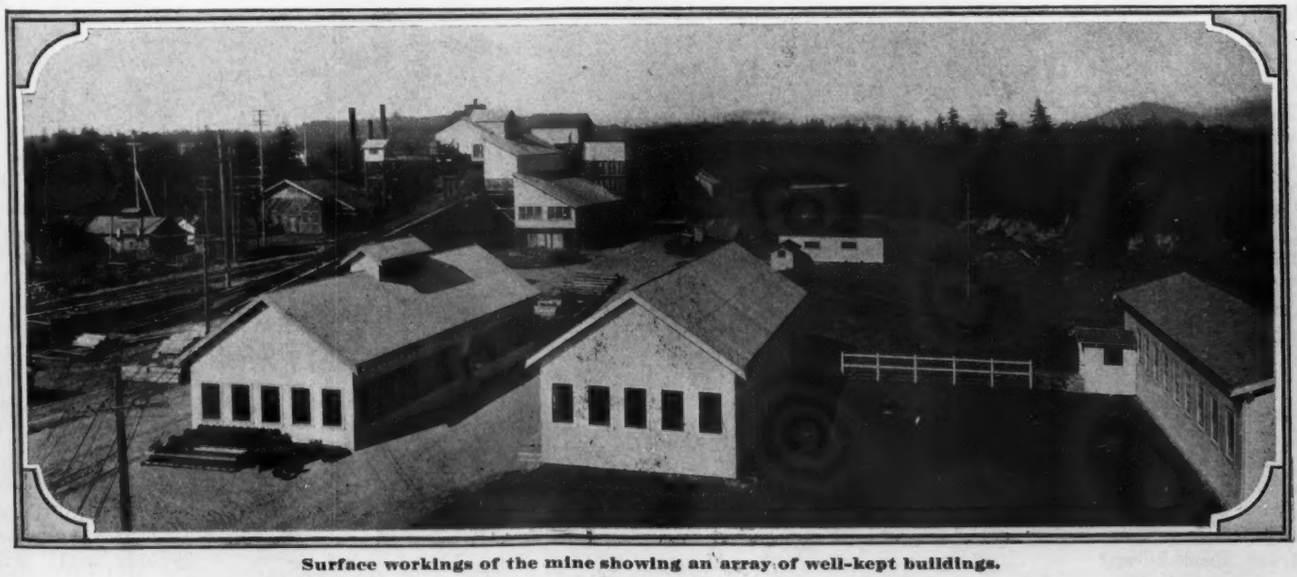
Mr. E. P. Lucas, general manager of Bellingham Coal Mines, has provided the following comprehensive and lucid description of operations at Mine No. 1, where Seam No. 1 lies at a vertical depth of 265 feet below the surface at the nearest point. The seam has an average dip of 10° from the horizontal and a bearing of 62° South 30″ West.

James H. Pascoe, familiarly known as "Smiling Jim", superintendent of Mine No. 1.

Beginning at the surface in November of 1918, the slope was driven down 600 feet on a 30° dip—intersecting a 13-foot seam at a vertical depth of 300 feet. Following this exploratory work, actual mining operations were not begun until August 15, 1919, when coal was hauled up the single-track slope in cars holding 2 tons net—six cars being brought to the surface at a trip. This procedure continued for the better part of five years, or until 1924, when the management decided to increase production in proportion to the increased sales. In order to do this, another slope was sunk on an 18° angle immediately above the No. 1 Slope for the purpose of intersecting the coal measures on the present workings at a point below the third level. The object was to bring up coal through either slope with the same hoisting engine and power, and thus make it possible to handle nine cars or 18 tons per trip on the new slope as against six cars or 12 tons per trip by way of the old slope.

The second slope was started late in 1924, and was completed and placed in operation on November 16, 1925. Today, all coal from the second and third levels is hoisted up the 30° slope, and all coal from the fourth, fifth, and sixth levels is hauled to the surface through the 18° slope. To change from one slope to the other it is only necessary to lift or to lower one end of a bridge that is operated by steam and hinged at its lower end. In other words, when the bridge is in its upper position the cars go down the old slope, and when the bridge is in the lower position then the cars go down the new slope.

The inside mining methods employed at Bellingham are generally similar to those followed in other mines using slope haulage. That is to say, at every 500 feet on the slope and to the right and the left, respectively, a pair of cross entries or levels are driven for a distance of 250 feet from the main slope before the first room is turned. This leaves a 250-foot pillar on each side of the slope. From this point rooms are broken off on 50-foot centers. Each room has a 30-foot neck and is then widened out to 20 feet, leaving



Surface workings of the mine showing an array of well-kept buildings.

Left—A "Little Tugger" hoist pulling a loaded coal car upgrade in the mine. Right—Drilling into the coal seam with a "Jackhamer".

a 30-foot pillar. All crosscuts are driven on 60-foot centers. Empty cars are taken to the working face by a double-track counterbalance—the loaded car that goes down one side pulling the empty car up the other side.

In some parts of the mine, where shortwall undercutting machines are employed, a panel incline is driven up through from one level to the other on the full rise of the seam, and the rooms are turned off right and left on 45-foot centers—the rooms being 20-feet with 25-foot pillars. At the top of the incline, at the level above, there is a small electric hoist which serves to pull the loaded car up out of the room neck and then to lower it to the level below, where the cars are made up into trips of six or nine, as the case may be. They are then hoisted to the surface where the cars are handled by a rotary power dump.

The coal is prepared for the market by hand picking the larger sizes and by screening and washing the smaller sizes. To be explicit, all coal that passes over a 3½-inch perforated shaking screen is graded as lump; that which is smaller than 3½ inches and more than 1¾ inches is classed as egg; and nut coal is minus 1¾ inches but bigger than ¾ inch. Coal that is less than ¾ inch but larger than 5/16 inch is graded as pea, and all coal 5/16 inch and smaller is steam coal.

After it has gone over the shaking screens, the lump coal is conveyed to a moving picking table, 48 inches wide by 50 feet long, and thence by way of a loading boom to waiting railroad cars. While passing over the picking table, rock or other impurities are removed and thrown into waste bins. Pieces of rock having coal clinging to them or pieces of high-ash coal are picked out and put into a bin leading to the crusher, by which they are reduced to minus 2 inches in size before being elevated to the raw-coal bins above the jigs. Most of the egg and nut coal is treated by three separate Forrester jigs, and from these jigs the coal flows to a Luhrig dewatering elevator which raises it to a point above a double shaking screen. There it is sized and separated with water before delivery to the railroad bins.

The raw pea and steam coal, after passing through the main shaking screens, is elevated and discharged into a 5/16-inch wire-mesh revolving screen—the pea coal going directly into a bin above the Faust jigs, and the steam coal dropping on to a 12-inch screw conveyor by which it is moved to bins above the washing tables. The pea coal is fed automatically to the jigs and thence flows to the boot of a Luhrig dewatering elevator which delivers it to the railroad bins. The steam coal passes from the bins, by individual automatic feed, to five Universal Overstrum washing tables and, next, goes to the boot of a dewatering elevator placed at the end of a settling tank. From this tank the coal is raised by an elevator to bins above the railroad track.

Moisture	6.010	per cent
Volatile matter	35.390	" "
Fixed carbon	42.820	" "
Ash	15.770	" "
Sulphur	.245	" "
B.T.U's	11,000	

The management is rightly proud of this well-appointed change house.

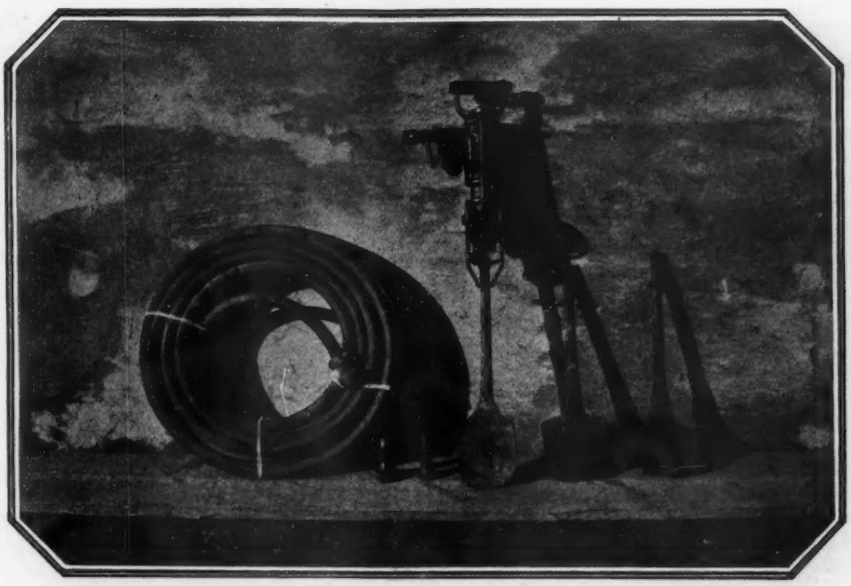
The general characteristics of the coal mined at Bellingham are shown by the foregoing approximate analysis of the average face sample.

Day in and day out, the tonnage handled in the plant ranges from 1,250 to 1,350 tons per 8-hour day, while the average tonnage of washed coal is anywhere from 1,050 to 1,150 tons, divided as follows: pea, 234 tons; slack, 260 tons; and egg and nut, 574 tons. The power consumption for the foregoing tonnage is about one-sixth of a horsepower per ton.

It may be of interest to many to learn that all shot holes in the coal are drilled with BBR-13

"Jackhamers". One "Jackhamer" is used to drill the rounds in two rooms when working up the pitch and shooting off the solid. When operating on the panel, where machine undercutting is done, one "Jackhamer" serves to do all the drilling required at four points. In entries and in air courses one "Jackhamer" is employed at each place. All holes are 6 feet deep.

The empty cars are pulled up to the working faces in the room necks by a number of No. 1H "Little Tugger" air-driven hoists, and the hoists are also utilized to lower the loaded cars to the entries. While breaking off rooms from entries when driving up the pitch, an advance of about 60 feet is made before the counterbalance rope and the McGinty wheel are put in. Electric hoists are employed on panel work because of the larger rope capacity there required.



"Jackhamer" equipped with improvised spades to serve as a clay digger.

The compressed air used in the mine is supplied by an XB-2 compressor driven by a 200-hp. motor. This compressor has an output of about 1,265 cubic feet of free air per minute. A smaller vertical compressor of Type 11, having a piston displacement of 60 cubic feet per minute, furnishes compressed air for odd jobs in the mine. A 2½-inch ST 2-stage Cameron centrifugal pump, direct connected to an electric motor, takes care of mine seepage. This unit is capable of pumping 150 gallons of water per minute against a total head of 225 feet. The mine is also equipped with several Cameron sinking pumps; but because of the very moderate amount of water to be handled only one of these Cameron sinkers is ordinarily required. Fresh water is supplied to the washing department of the plant by a No. 5 SV belted Cameron pump. This pump draws water from a creek running near the plant; and the machine has a capacity of 800 gallons per minute at a 70-foot head. A second No. 5 SV pump is used to return sludge to the washing system.

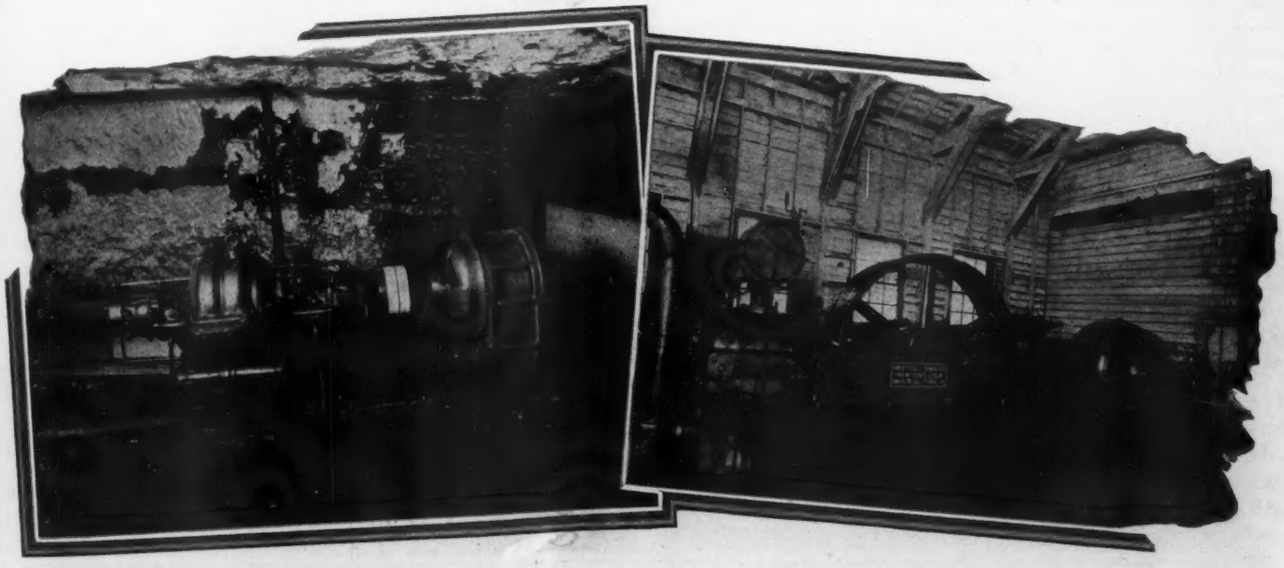
The forced ventilation of the mine is insured by a 48-inch fan that has a capacity of 75,000 cubic feet per minute against a 3-inch water column. A 15-ton Link-Belt locomotive crane serves to shift railroad cars and to deliver coal to storage piles when necessary. An average of 8 tons of coal is mined by each miner during an 8-hour shift. Or, proportioning the output among the entire working force, each employee produces 4.34 tons of coal per 8-hour shift.

The management has done much to insure the welfare and the comfort of its operatives; and the accompanying photograph of the neat change house is one indication of this. The rescue team from this mine won the cup four years ago, but since then has not competed in the mine-rescue contest held annually in the United States.

Mr. James H. Pascoe, superintendent, and Mr. William Williams, master mechanic, have been identified with this mine practically since its inception, and have ably handled the work of putting it into the heavy-producer class.

SUKKUR IRRIGATING PROJECT WELL UNDERWAY

IN a recent progress report on the great Sukkur Barrage and Canal Construction Scheme in India the belief was expressed that the project, which was begun on July 1, 1923, may be completed in 1933, as originally planned. So far, a total of 866,800,000 cubic feet of earth has already been removed in building the dam across the River Indus and in digging the far-reaching system of canals that will ultimately irrigate 5,000,000 acres annually. It is estimated that 4,645,000,000 cubic feet of materials must still be excavated before the 5,000 and more miles of canals are ready to deliver their beneficent flood to a region so often sorely in need of water.



Left—One of the several Cameron pumps on the mine property. Right—The XB-2 compressor, driven by a 200-hp. motor, which furnishes 1,265 cubic feet of free air a minute for use in and about the mine.

New Zealand Has Novel River Sweeper

NO small part of the quaint charm of Christchurch, New Zealand, is due to the manner in which the Avon River winds through the center of that city. The banks of this stream are made picturesque by terraces and abundant shade trees. The Avon, however, is a river of very moderate currents. During the rainy season, silt and other materials are carried into the stream, and no small part of this matter accumulates upon the water bed—thus obstructing or shallowing the channel. The problem has been to devise some effective yet relatively inexpensive equipment that would stir up this deposit and aid it to move seaward during ebb tides. According to *Commerce Reports*, such an apparatus has been devised: and it is said to perform efficiently the work expected of it.

Courtesy U. S. Dept. of Commerce.

River-sweeping craft in service at Christchurch, New Zealand.

We are indebted to Consul General W. L. Lowrie, at Wellington, for the following particulars. The inventor of the floating plant first built a small machine which was tested by the city authorities and found capable of doing useful work. Upon the strength of that, the municipal corporation justified the building of a larger and more powerful machine—a picture of which is shown herewith. The apparatus is not a dredge in the stricter sense of the term—it may more properly be described as a hydraulic river sweeper. The floating equipment consists of three gasoline engines coupled to three centrifugal pumps. These pumps take water in at the stern and discharge it through three 5-inch pipes, each of which terminates in a 1⅜-inch nozzle projecting from the bow of the pontoon or barge on which the engines are assembled. The action of these nozzles resembles to a degree the operation of water jets extensively used in New Zealand in the mining of gold by sluicing away large banks of earth.

The secret of the sweeper's efficiency, so it is said, is due to the air attachment — a short length of smaller pipe on each discharge pipe—by means of which air is drawn into the water pipe. This air forms a sleeve around the water jet as it emerges from the nozzle. That is to say, the water and the air on issuing from the nozzle produce an explosive effect that churns up the debris, shingle, and sand deposited on the river bed; and this disturbed material is held in suspension for some time and carried downstream and seaward. It is understandable that the air drawn into the pipe is compressed by the pumped water before reaching the discharge nozzle. and that it expands rapidly and forcibly when released—the effectiveness of the water jet being increased proportionately.

The river sweeper is now the property of the Christchurch Drainage Board, the purchase price being about $8,250. At the time the information was primarily furnished by the American consular agent at Christchurch, the river bed had been swept for a distance of a mile, and the hydro-pneumatic apparatus had fulfilled expectations. It has been suggested that the use of a small compressor would add considerably to the scouring action; but the answer to this was that the volume of water in the Avon is not sufficient to carry away promptly the extra material that would be dislodged in that way. However, a river sweeper so equipped might prove just the thing in dealing with other streams where the tidal flow and the volume of water are greater.

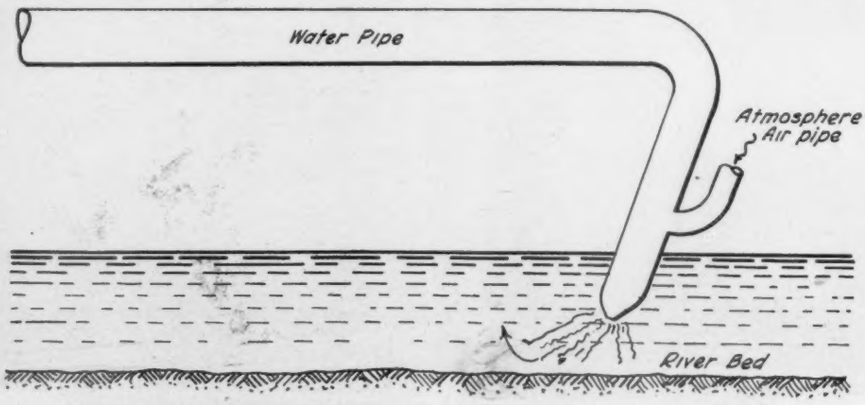


Diagram of the discharge nozzle of the hydro-pneumatic river-bed sweeper. The water on its way to the nozzle induces a suction in the associate air pipe, and the inflowing air mixes with the water and increases the scouring effect of the jet.

Sulphite lye, a by-product in the manufacture of sulphite pulp, is being put to commercial use in Sweden, so it is reported. This waste liquor is being made into printers' ink by a process developed for that purpose.

MAKING TRANSPARENT METAL FILMS

BY a process developed by Dr. Carl Mueller of Berlin, Germany, sheets of metal can be produced that are so extremely thin and transparent that ordinary type can be read through them. At least, so it is reported in *Nature*, which gives the following additional details regarding the process and the product.

The sheets are formed by the electrolytic method—the metal being deposited on the surface of some soluble substance, such as rock salt, which can be melted readily afterwards. Iron, nickel, gold, silver, and platinum have been used in the manufacture of these films, which are so thin that it would take 2,500,000 of them to make a pile an inch high.

Being virtually little else but surface, these films are said to possess high electric conductivity. In fact, it has been found that a strip containing no more metal than that in a piece of round wire one-hundredth of a millimeter in diameter will safely carry sufficient current to light several lamps. This same voltage, if passed through the wire, would instantly melt the metal.

There will, no doubt, be found many applications for such thin sheets of metal of different kinds; and one extensive field might be in the making of phonograph and radio reproducers, as the average diaphragm in use today is so heavy that it dampens some of the overtones and thus tends to coarsen the sounds.

School Magazines an Aid in Education

By A. M. HOFFMANN

YOUNGSTERS of today, upon leaving school, are far better qualified than they used to be to take their places in the ranks of wage earners. Not so much, perhaps, because they are better equipped mentally, as far as reading, writing, and arithmetic are concerned, but because the classroom work and other incidental school interests now include courses and activities that help to turn out a more finished product. It is not our purpose to go into the details of the modern educational system other than to say that by reason of it the average girl or boy of the present day, aside from the learning acquired, is more alert, has more self-possession, and is better able to express himself after finishing grammar school than was the less fortunate youngster of not so many years ago.

School papers or magazines have undoubtedly done more than anything else to stimulate the powers of observation and self-expression. These publications do not confine themselves to school topics: they now include all sorts of timely subjects, many of them resulting from visits to local points of interest, industrial plants, etc. To show how the youthful mind reacts to opportunities of this sort, a single instance will suffice to bring this home. Sterling Snyder—a student of Class 8A and representing *The Sitgreaves*, published by the seventh- and eighth-grade pupils of a school in Phillipsburg, N. J.—was given permission to go through the local shops of the Ingersoll-Rand Company. On the strength of that visit, he wrote the following story for his school paper:

"Though many of us do not know it, we have many important industries in Phillipsburg. The most important of these is the Ingersoll-Rand Company. It is located in the eastern part of the town, and it is one of the largest of its kind in the world. The original plant was started in New York in 1871, and it moved to Easton in 1893. The present plant in Phillipsburg was started in 1903, and consists of 260 acres with 20 buildings on 20 acres of this ground From 2,500 to 3,000 men are employed in this plant. The Easton plant is also still in operation, and there are three other plants in other parts of the country.

"The Phillipsburg works have their own water supply, which comes from a dam north of Stewartsville. This dam holds 33,000,000 gallons of water which supplies a sub-reservoir which holds about 2,500,000 gallons. The water is carried to the plant by five miles of 10-inch pipe.

"The most important products of this plant are the rock drills and air compressors. Other products are oil engines for general use, Cameron pumps, turbo-blowers for blast furnaces, and oil engines for oil-electric locomotives. Ingersoll-Rand products are used all over the world, especially the rock drills and air compressors. The oil engines are becoming another important product because of the cleanliness and cheapness of operation.

"The plant is served by two railroads, the New Jersey Central and the Lackawanna, which carry the products to all parts of the country. The main offices of the Ingersoll-Rand Company are in New York City. Branch offices are located throughout the United States and in nearly every country of Europe. Offices are also located in Asia, Africa, and Australia.

"The plant operates its own cafeteria. A club house is also provided for the employees, and a mutual benefit association is carried on. The apprentice training school which is maintained by the plant is a great help to young men who wish to learn a trade. This training school is one of the best known in the state of New Jersey. Boys from the age of 16 to 18 are selected and trained in "shop engineering" and many other trades. The apprentice training school has a basketball team which has made a good record this year. There is also an apprentice baseball team."

While on this subject of school magazines, it may interest some of our readers to know that there is held annually at Columbia University, in New York City, a convention of the Columbia Scholastic Press Association, an organization of amateur publishers of papers and magazines of both public and private schools below the rank of college. The aims of this association, which was created in 1925, are to stimulate an interest in

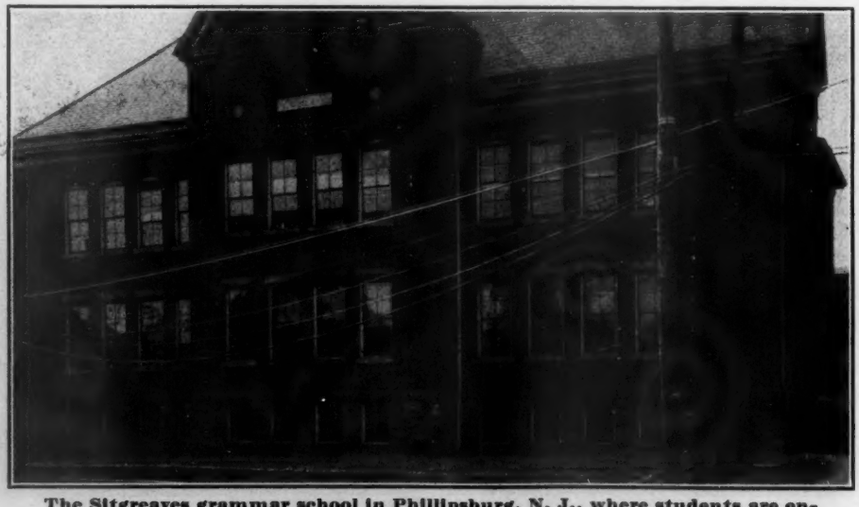
This is the industrial plant visited by Sterling Snyder for the purpose of writing an article about it for his school monthly.

Sterling Snyder, the enterprising eighth-grade pupil of the Sitgreaves, who wrote the accompanying article.

school papers, to help organize them, and to furnish information in regard to all phases of the work of writing, editing, and publishing.

The convention is held in March of each year, and the youthful delegates spend their time visiting newspaper offices and listening to lectures by men and women prominent in the field of journalism. One of the outstanding features of the two days' session is a contest—various prizes being awarded for the best papers and magazines entered. In the short time that the association has been active, the number of delegates attending the convention has grown from 400 in 1925 to 1,200 in 1927. That year well-nigh every state in the Union was represented—including Alaska, the Canal Zone, and even Hawaii; and 377 papers were entered in the contest.

Whether or not the boys and the girls that now play a part in the preparation and publication of school papers decide, later on, to take up their particular work as a means of livelihood, the experience is bound to benefit them greatly. That this is being appreciated is brought out by the fact that the school magazine is today considered by the National Education Association an important factor in the development of Young America.



The Sitgreaves grammar school in Phillipsburg, N. J., where students are encouraged to go afield in gathering material for publication in their monthly magazine.

HEAVY MATERIALS HANDLED BY PNEUMATIC CONVEYOR

A PNEUMATIC conveyor system for the handling of irregularly shaped and heavy materials such as coal, ashes, iron ore, limestone, etc., has been devised and put to practical use in a factory in London. The success of the system depends upon the employment of a cyclone discharger and a water-sealed rotary vacuum pump of special design.

The vacuum pump, according to *Engineering*, consists of a shaft provided with vanes revolving in an elliptically shaped shell, and is said to give a notably large flow of nonpulsating air. The following additional details regarding this new conveyor have been taken from the same source. A fixed amount of water is kept within the shell and is compelled to move with the revolving vanes. However, due to centrifugal force, it follows the shape of the shell so that at the extreme ends of the ellipse the water between any two vanes moves away from the shaft. The intake pipes are at these points, and the resulting vacuum draws the air from the system. As the vanes approach the narrow sides of the ellipse the water is carried toward the shaft, forcing the air out through exhaust pipes placed at those points. The water is fed slowly into the shell from a valve at the top—the heated water being drawn off below.

Apart from the necessity of supplying a large volume of air, a successful system must be provided with means capable of preventing dust and small particles of the conveyed material from reaching the exhauster. Ordinarily cloth filters are used; but in the handling of coal and other explosive dusts the fire risk would be too great, not to mention the need of frequent cleaning. To overcome this difficulty a cyclone discharger was put in the pipe line between the suction nozzle and the pump, thus assuring almost complete automatic separation of the dust. The slight amount of dust passing the discharger is rendered ineffective by the type of pump used.

The cyclone discharge apparatus consists of a series of conical baffle plates which the materials enter at a tangent. The heavy coal immediately falls into a receptacle below, while the dust spirals around the cones and moves toward their smaller ends, whence it is discharged and finally drops into a receptacle with the coal. This receptacle is in the form of a cylinder which is held stationary by the pressure of the outside atmosphere and a system of levers until it is filled. Then it begins to slide down vertical guides. In its descent the cylinder opens a lower door, thus breaking the vacuum and allowing the coal to fall out. With the weight of the coal removed. the carrier returns to be recharged—closing the door as it ascends. In this way no outside air can destroy the vacuum within the system while the cylinder is being emptied.

It is claimed that the limit of vertical lift by this system has not yet been reached in practice and that the distance of horizontal movement seems to be merely a matter of power. Wear on the piping is small, provided there are no sharp bends or poorly aligned joints. These are apt to cause eddies in the air, thus sweeping the material against the walls instead of carrying it in the center of the conveyor.

© Acme Newspictures

This air-operated apparatus, which was tested in Boston Harbor, is designed to make possible the passing of food, water, and fresh air to men trapped in a submerged submarine. How the contrivance works has not been disclosed.

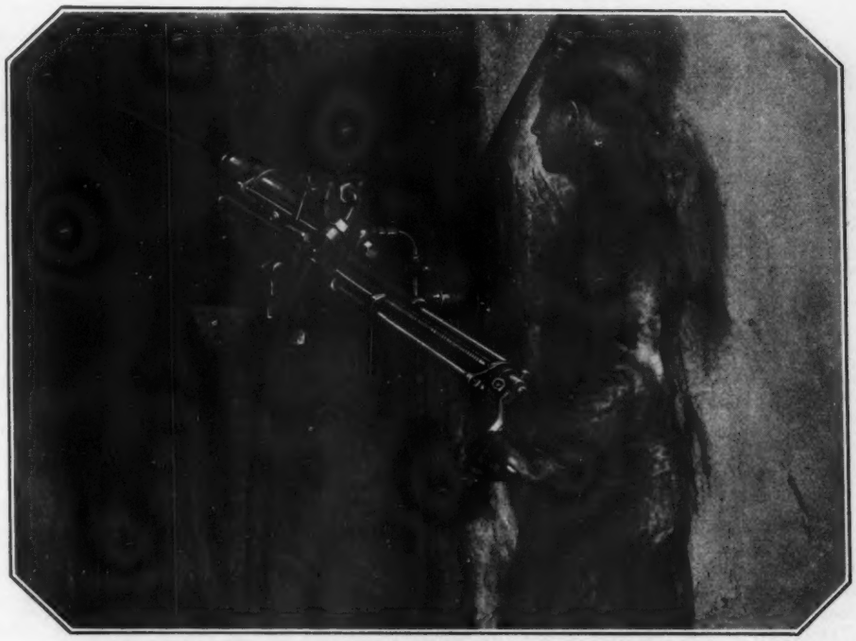
History of the Hecla Mine

Despite Early Setbacks This Mine Has Since Warranted Dividends Totaling More Than $17,000,000

PART I

By JAMES F. McCARTHY*

THE ultimate success of a mining property depends not alone upon the mineral wealth stored in the geological formation but likewise upon the men responsible for the management of the property at every stage of the undertaking. The Hecla Mine, at Burke, Idaho, is no exception to this rule; and in order that it can properly be evaluated as a producer, the following historical particulars have been compiled.



An N-72 drifter at work on the 2,000-foot level of the Hecla Mine.

The present Hecla Mining Company is a Washington corporation: the original organization was the Hecla Company of Idaho. The older corporation owned two claims, the Hecla and the Katie May, and was incorporated for 500,000 shares of one dollar par value. The principal shareholders and officials of this company were made up of the early mining men of the camp. Among the active officials were John A. Finch and A. B. Campbell; and among the directors and the shareholders were Patrick Clark, J. R. Smith, Frank Upman, F. J. Kipp, Charles Kipp, B. A. Kipp, and Carl Landsee. Carl Landsee and Clarence Kipp, a son of F. J. Kipp, are directors of the present company.

An examination of the books of the old company fails to disclose the amount of money realized from the sale of its shares, but it does show that an assessment of 1 per cent was levied on June 15, 1892. A second assessment of the same amount was levied later in that year. There are no entries in the journal from November, 1892, until February, 1897, when an entry was made of a charge by the Milwaukee Mining Company for milling ore from a Hecla lease at 84½ cents per ton. Then the lease, which ran to Browning, Callahan & Company, was canceled by the payment to that company of $1,375.56 for cancellation of the lease and for a bill of sale for tools and supplies. In July, 1897, two more assessments, each of 1 per cent, were levied. Part of these seem to have been paid to the Milwaukee Mining Company for supplies and for milling the lessee's ore. This company was then in possession of the mill, located at Gem, that is now owned and used by the Hecla Mining Company.

What is known as No. 3 Level was started by the Hecla Mining Company. This level encountered the vein within a few feet of the portal and followed it thereafter. At a point 350 feet from the portal a narrow seam of galena was reached. This was hardly com-

*General Manager, Hecla Mine.

Commodious compressor room of the Hecla Mine at Burke, Idaho, with space remaining for additional compressors. The big units indicate how important a part compressed air plays in the operation of this mining property.

Collar of shaft at the Hecla Mine.

mercial. Drifting stopped a short distance beyond to the east, not far from the company's property line. Later, a lease was given to Joseph Dolan, who had associated with him Dan Cardoner and John Clark. Dolan and Clark were practical miners. Cardoner was a Burke merchant, later an owner in the Hercules Mine, who retired some years ago to his home in Spain, where he died.

On the strength of the small showing just mentioned, these lessees sank a winze to a depth of approximately 150 feet. No improvement in the showing was realized from this development. Funds were exhausted, and the work stopped. It is an interesting fact that later developments revealed that the main ore body of the Hecla Mine would have been discovered if a small sum—equal to that expended in sinking—had been spent in drifting. The extension of this drift would have required the purchase of additional ground; and this ground was subsequently acquired.

The Idaho corporation was reorganized as a Washington corporation, still of the same name, on a basis of 1,000,000 shares of 25 cents each, and the newer company absorbed the older one—the consideration being one-half of the new company's shares for the property and assets of the original concern. The remainder of the shares was sold to shareholders of the older company at 10 cents a share; and $50,000 was realized for expansion and development.

An option to purchase the Ore-Or-No-Go fraction was taken from John Doherty, Mike Maher, and John Stack—the last named now living at Republic, Wash.—for $3,000 payable in installments over a period of fifteen months. In addition, an option to buy the Orphan Boy, Orphan Girl, Denver, Silvante, Climax, and Leadville claims was taken from John H. Van Dorn, who is today a resident of Spokane. The consideration was $36,000 payable in installments over fifteen months.

The claims purchased under these options contained the main Hecla ore shoot from which the greater part of the production has come. This ore lies in the Ore-Or-No-Go fraction, the Orphan Boy, and the Orphan Girl. The reorganized company promptly resumed drifting on the vein in No. 3 Level, and after advancing a very short distance encountered the Hecla ore shoot. From that time on there has been a gradual expansion in the company's production.

The Hecla Mining Company was always closely identified with the Standard Mining Company until the sale of the latter's property to the Federal Mining & Smelting Company in 1903. With that sale, the Finch and Campbell organization was less active in the Coeur d'Alene; and the presidency of the company passed to J. R. Smith, who remained in that position until his death.

The first ore mined after the reorganization was concentrated in the Standard Mining Company's mill at Wallace; and production was made through that mill until some time in 1900 when the concentrator, which the Hecla Mining Company now owns, was purchased from the Milwaukee Mining Company. The mill then had a capacity of from 200 to 250 tons. Additions, that were made on two occasions, resulted in a capacity to handle from 700 to 750 tons daily. Dividends amounting to $100,000 were paid in 1900. Thereafter, no dividends were declared until 1903, and since then they have been paid virtually without interruption.

While the principal ore production has come from the Hecla ore shoot, still two other ore shoots have developed—namely, the East Ore and the Ore-Or-No-Go. The East Ore body became much advertised on account of the litigation with the Marsh and the Federal companies over its ownership. The suit was settled by the purchase of the Tiger-Poorman group of claims from the Federal Mining & Smelting Company, which owned the Russell claim. This claim, so it was asserted, covered the apex to the ore. The Ore-Or-No-Go ore occurs in the claim of that name, and carries a mixed lead-zinc content. From this source no production was made except about 120,000 tons above water level in 1917 and 1918.

The company has had among its business and operating officials some well-known men long identified with northwestern mining affairs. John A. Finch and A. B. Campbell, who were among its first officers, were pioneer operators in the district and were responsible for the development of the Gem Mine, the Standard Mine, and for the early work on the Hecla Mine. They were interested in the Mammoth Company and in a number of other less successful operations. They developed the Kendall in Montana, the Standard Silver-Lead Company in British Columbia, and were in the War Eagle and other properties in Rossland.

Patrick Clark, one of the incorporators of

Surface plant and office buildings of the Hecla Mine. These buildings, except the office which is of brick, are of concrete and steel construction.

the Hecla, was the first manager of the Poorman Mine in Burke and one of the early mine superintendents in Butte—in fact, I believe, he worked in the first shaft sunk in Butte. James R. Smith, who succeeded Mr. Finch as president of the company, was one of its incorporators. He, in turn, was succeeded by Frank Upman, since deceased. The surviving members of the families, in both instances, have retained their interests in the company.

F. J. Kipp and Carl Landsee were among the original shareholders, as were also two of Mr. Kipp's brothers. J. R. Finley, one of the best-known engineers in the country, was superintendent of the Standard and the Hecla and, later, manager of the Goldfield Consolidated and of the Portland Mine in Cripple Creek. He is accepted as an authority on mining costs. R. K. Neill was one of the first superintendents of the property, and at that time was associated with Finch and Campbell. Mr. Neill was afterwards identified with the development of projects in Kendall, Mont., and in British Columbia. His latest and, perhaps, most profitable venture is the Premier Mine in British Columbia.

The record of production and of dividends for the Hecla Mine to the close of 1927 is as follows:

Tons mined	4,782,098
Tons shipped	642,890
Pounds of lead	727,885,400
Pounds of zinc	941,229
Ounces of silver	19,997,676
Dividends	$17,105,000

The most interesting development in recent years has been that involving the connecting of the Hecla Mine at the 2,000 foot level, with the Star Mine. The distance from the Hecla shaft to the Star vein is about 9,000 feet. This work was finished in March of 1924.

(To be continued)

MOTOR BEARING USING COMPRESSED GAS

A RECENT issue of the *Journal de Physique* contains the following interesting announcement regarding the use of gas or air in connection with bearings for small motors. The fixed part of bearings of this type, which should be mounted so that a little side play is possible, is a vertical cone of semi-vertical angle of about 60° and 0.3937-inch side. Halfway down the side there are eight or ten holes up which air or carbonic acid gas at from 2 to 6 atmospheres pressure is forced. The rotary part is coned underneath, the semi-vertical angle being about 65°; and the conical surface is provided with fine grooves along its generating lines. With a rotor 0.3937-inch in diameter, a speed of 11,000 revolutions per second was obtained, and with it the Foucault measurement of the speed of light could be made with the reflecting mirror only 3.28 feet away. Rotors weighing 5.5 pounds have been driven at 1,100 revolutions per second.

Since the first American-made cars were assembled abroad in 1923, the number of foreign assembly plants of American automobile companies has increased from 6 to 29

DIESEL-ELECTRIC TANKER "BRUNSWICK"

THE employment of Diesel-electric drive for merchant craft is widening steadily. The latest and the most outstanding application in this field of service is that in the case of the tanker *Brunswick*, recently launched in Greenock, Scotland, at the plant of Scott's Shipbuilding & Engineering Company. The *Brunswick* is a vessel of 12,500 tons dead weight, and is being constructed for the Atlantic Refining Company of Philadelphia, Pa. This enterprising company has in commission, at the present time, the largest fleet of Diesel-electric merchant vessels in the world, all equipped with Ingersoll-Rand solid-injection oil engines; and its determination to use the same system of drive in the case of the *Brunswick* was the outcome of ripe and satisfying experience. The Ingersoll-Rand Company has furnished oil engines for four tankers, four ferries, and seven tugs that have Diesel-electric drive.

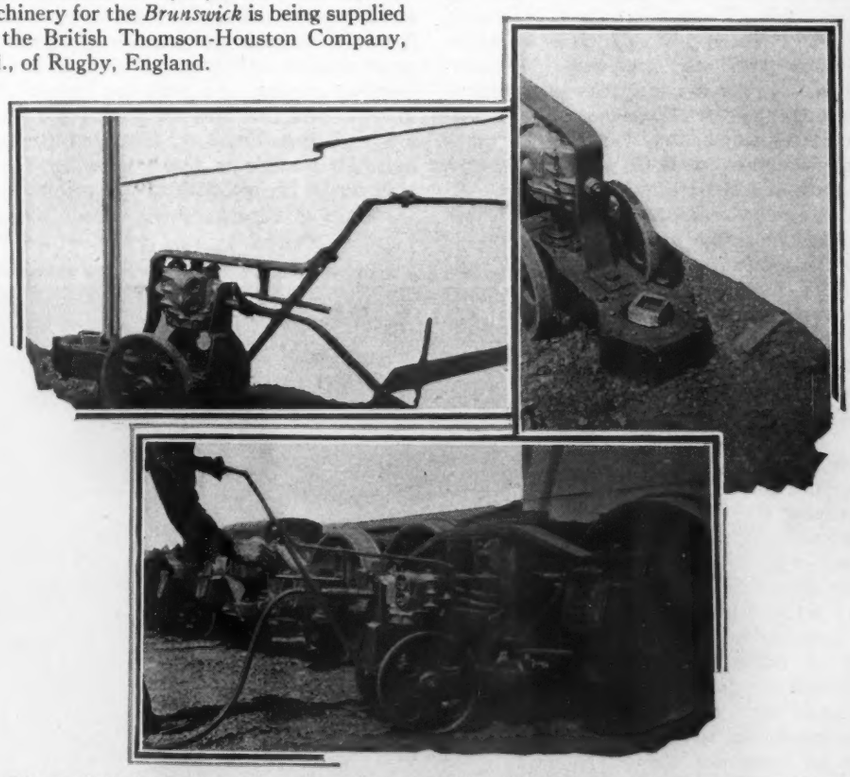
The *Brunswick* has a length of 469 feet, a beam of 63 feet, and a molded depth of 36 feet 9 inches. She is designed to make 11 knots an hour at full speed. To do this she will be equipped with four Carels-Ingersoll-Rand, 4-cycle, solid-injection, Diesel engines, each of 750 b.hp., built by the well-known firm of Carels Fréres, of Ghent, Belgium. The engines drive dynamos which, in turn, furnish electricity to the main propelling motor, rated at 2,800 b.hp. The air compressors for starting the oil engines have been provided by the Ingersoll-Rand Company, and the electric machinery for the *Brunswick* is being supplied by the British Thomson-Houston Company, Ltd., of Rugby, England.

ELEVATORS HANDLE HEAVY PASSENGER TRAFFIC

JUST how numerous are the "ups and downs" of elevators in busy office buildings in large cities may surprise even those of us who travel in them daily. A company operating a number of structures of this kind in New York has recently published the following facts and figures on this subject.

During 305 working days in 1927, the elevators in fifteen prominent office buildings in the Grand Central zone transported 33,592,348 persons in both directions. The total number of trips made by the 107 cars in question was 4,577,583, and the aggregate distance covered was 378,000 miles—enough to encircle the globe fifteen times. The statement is concluded with the simple though significant comment that "there has not been a serious elevator accident in those buildings in ten years, and during the last two years cars have been stalled only four times."

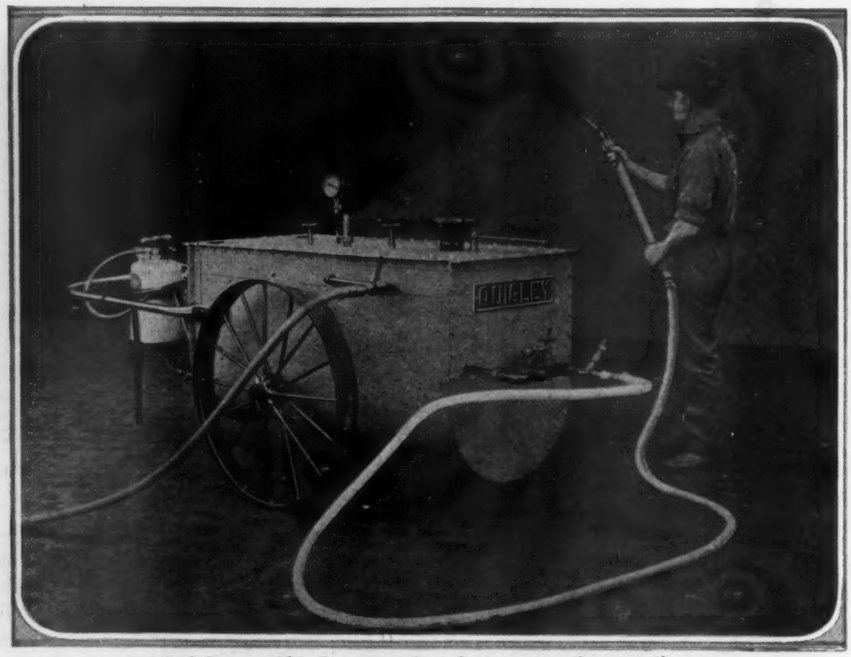
An attempt is being made to establish a tin-mining industry in southern Oregon as the result of the discovery of a process for the recovery of tin from ores said to abound in that region. Just what the process constitutes has not been made known; but the *Pacific Coast Miner* reports that laboratory tests have shown the presence of 6½ per cent of tin in samples of ore from the Iron Creek district.



These pictures show an ingenious car-truck bolt wrench fitted with an Ingersoll-Rand air-operated AA drill—the purpose being to save labor and time in running on and off car-truck bolt nuts. One railroad used two of these special wrenches on a certain line and, as a result, reduced the truck gang from twelve men to six men and effected a saving of $30 a day. The square socket shown in the upper right-hand picture serves to tighten the nuts, and is driven by a square-end shaft. The socket is lifted out and a thinner one put in when tightening lock nuts. This machine, when used on 1¼-inch car-truck bolt nuts, ran the nuts on so securely that a man with a 3-foot wrench could not tighten them further.

Air-Operated Gun Sprays Hot Fluids

THE old rusty melting pot, sloppy bucket, and dripping mop or brush—used in connection with work calling for the application of protective coatings of hot tar, asphalt, pitch, etc.—can now be consigned to the scrap heap. At least, that is what the Quigley Furnace Specialties Company, of New York City, has to say in announcing its new air-operated gun designed especially for spraying fluids of well-nigh any consistency and temperature.



Quigley outfit for spraying hot protective coatings.

The gun consists of a cast-iron cylinder from which the fluid mass is ejected by a piston capable of exerting sufficient pressure to deliver the material at any point within a range of several hundred feet from the gun. Insulated, metallic hose is used; and special nozzles are supplied to meet differing needs. These nozzles have discharges that can be set at any angle so as to be able to reach with ease otherwise inaccessible places. The gun has a capacity of 15 gallons, or enough to cover approximately 400 square feet of surface; and to facilitate shifting it from place to place, as the work progresses, it is housed and mounted on wheels.

Two men are needed to operate the machine: one to handle the gun and the other to manipulate the air supply and to charge the gun. This is said to be but a matter of moments—compressed air serving to send the piston back to the loading position. After loading, pressure is applied to the piston by closing the charging vent and opening another vent, both of which are provided with quick-acting valves. The air consumption is low, only 15 cubic feet at 60 pounds pressure being required per minute. Compressed air is also used to clean out the hose after the day's work is done. For this purpose the air is heated by means of a coil fitted inside the gun housing.

The temperature within the gun is regulated by a small self-contained kerosene burner; and it is claimed that the heat of the mass, as it travels through the hose, is not reduced more than three degrees for each 25 feet of distance carried. As both the heat of the material and the pressure behind the spray are at all times under the control of the operator, it is possible to assure penetration and adhesion of the coating at any point within the limits of the gun.

Air-operated gun spraying a bituminous coating on a penstock.

Obviously, the new spray gun is a big improvement over the old, primitive methods of applying hot fluid and semifluid substances. On a big penstock job, for example, according to the manufacturer, two men with this modern equipment were able to do the work that had previously called for the services of twelve men with mops and sprinkling cans. The gun sprayed the material at the rate of 5 gallons a minute, covering within that time approximately 125 square feet of surface and penetrating every crack and crevice with ease. The savings to be effected by this process are said to be so great that the gun may pay for itself on a single large job.

TEAR GAS AN EFFECTIVE FUMIGANT

THE use of tear gas to kill insect pests seems to be an unusual application of this pungent gas that is employed by the police and for military purposes to dislodge the criminal or to rout an enemy. According to a recent news item, tear gas is doing effective service as a fumigant in a flour mill. To kill any insect pests that may have been brought into the mill by the wheat, all doors and windows are sealed and the gas is released.

It has been found, so it is reported, that this gas will penetrate not only every crack and crevice in the mill but also bulk grain or grain in sacks—killing both the eggs and the fully developed pests. While destructive to all forms of insect life, tear gas is not fatal to human beings except when they are long confined in an atmosphere saturated with this fumigant. Tear gas is said to possess the added advantage of non-inflammability.

Care of Ammonia Compressors

Units Should Be Regularly Inspected and Overhauled to Get Efficient and Sustained Satisfactory Performance

By W. D. WHALEY*

THE task of inspecting and overhauling an ammonia compressor is a more important one than many engineers of our profession seem to appreciate. This is especially true where the machine to be overhauled is a unit in a group of machines upon which the owner depends when the time arrives for full production.

In a large number of plants throughout the country the greatest part of the earnings come within a short period of time, probably an average of six to seven months. During this relatively brief period it is important that the equipment shall be in good state of repair, and that the one responsible for the overhauling of the compressors should be thoroughly fit for the job—that is, able to make an intelligent and comprehensive inspection and to carry out the work after approval.

It is more practical to begin an inspection of an ammonia compressor during the heavy production season than it is to wait until the machine is shut down at the end of the season. This is essentially true because there are some points that can be checked up and recorded during the time the machine is operating at full capacity that would escape even a well-trained engineer should he wait until the unit is shut down for the season. These points are: Movement of machine on foundation; undue lateral movement of shaft in bearings; rise and fall of rod through packing; slamming or sticking of valves; wabbling of flywheel; heating or knocking of bearings; packing trouble; ammonia leaks around joints; and condition of unit as shown by indicator cards.

Following the plan already noted, the plant engineer will be equipped at the end of the operating season with a considerable amount of notes, indicator cards, and information that will guide him intelligently toward the laying out of his overhauling program. Having shut down the unit, his next step is to open up the machine, clean such parts as need cleaning, and inspect each part in order to confirm or tie in with the information or records he has secured while the plant was running.

The piston should be removed, and the walls measured and inspected. To be in good condition, the cylinder should be round and free from scores. Rings should have a reasonable tension against the wall; should fit the grooves, be just loose enough to be free; should have no wire edges; and the clearance at ends of rings should be approximately 1/64 inch. Quite often it is necessary to renew the rings, and it is desirable to keep them in good order. If it is found on inspection that the cylinder and the piston are worn to a point where there is too much tolerance, as indicated by a slap while running, it will be needful to fit a new piston and probably to bore the cylinder.

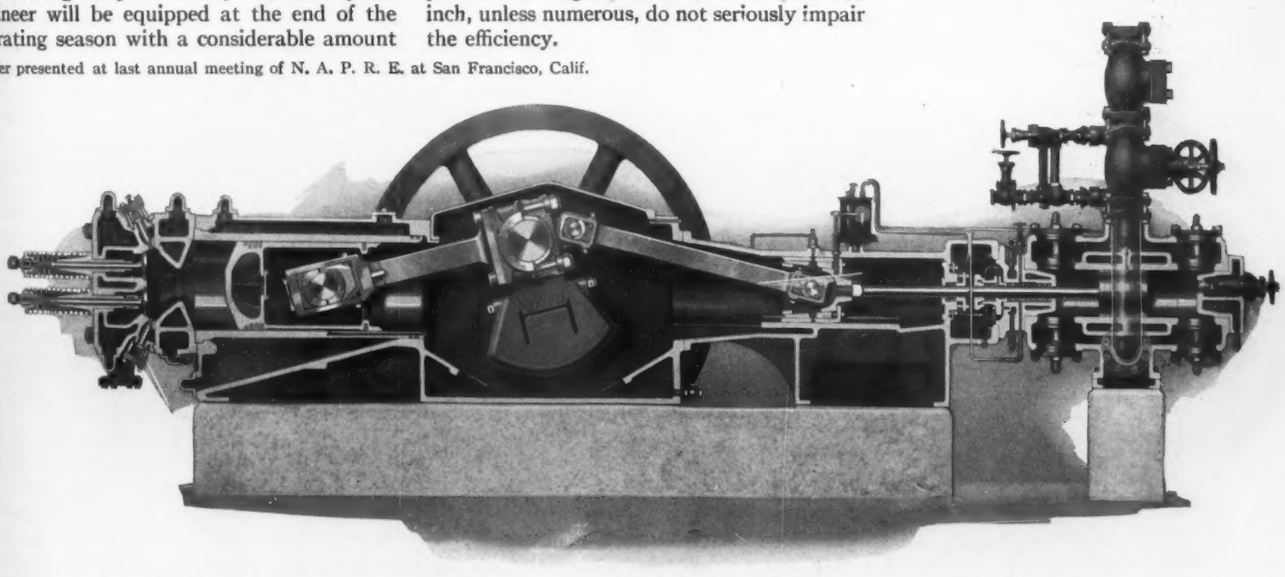
This prompts the question: "When is it time to bore a cylinder—that is, what condition requires a boring job?" Many and varied are the answers given to this question. From personal experience I am convinced that a maximum of .002 inch out of round per inch of diameter is the maximum beyond which a fair degree of compressor efficiency cannot be maintained. If the cylinder is heavily scored, say 1/32 inch and more deep, it is a good investment to bore it to fit a new piston and rings. Scores smaller than 1/32 inch, unless numerous, do not seriously impair the efficiency.

Cylinder boring is the most important job we have to contend with in repairs to compressors. Generally it is a contract matter, and someone in the employ of the plant owner or in whom he has confidence must see to it that the contractor is competent and equipped with a proper tool. The bar should be large enough so that there will be a minimum of deflection, that it will be properly secured in the bearings, and firmly fastened in position. The lining up of a bar is most important.

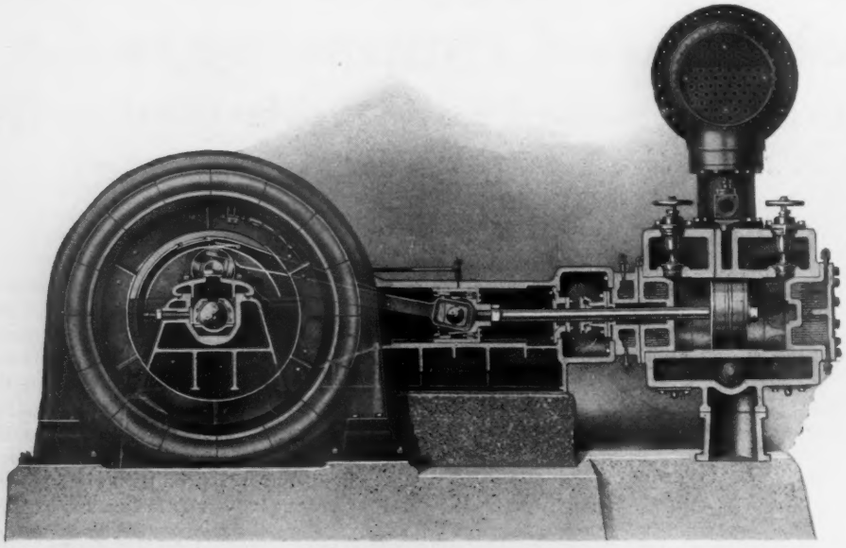
To properly line up a bar it is necessary to run a line through the cylinder and to locate it in such a position that, if the cylinder should be bored to the line, the piston will run true at all points of the stroke. While such a line, when set, will generally pass through the center of the counterbore, gasket groove, or neck bushing in the packing box, this is not always the case. Frequently machines are found in which these points are off center. In such a case, it is necessary to make marks on cylinder faces equidistant from the line to be used in centralizing the bar when it is set up.

I cannot emphasize this point too strongly since the true operating of the rod and piston depend on the set up of the bar. The line should strike in the center of the crank pin—measured longitudinally—on the crank end and strike through the center of the counter bore or gasket groove on the head end. Guides should be checked against the line and, if found to be out so that the rod will move out of alignment more than .015 inch, or if hol-

*Paper presented at last annual meeting of N. A. P. R. E. at San Francisco, Calif.



Longitudinal section of an oil-engine-driven ammonia compressor of the well-known POC-A type.



Longitudinal section of a PRE-A electrically driven ammonia compressor.

lowed out more than .015 inch, should be bored with the cylinder. Rings should be made of a close-grain, gray cast iron, finished after cutting, and should fit freely in the groove. Corners should be taken off slightly, just enough so that a burr will not wear on any of the rings by the time it is broken in. Clearance on end should be .001 inch per inch of diameter of cylinder.

The piston should be of a good grade of cast iron. It is customary to make the larger sizes of pistons hollow, and care should be taken to see that there is plenty of metal thickness and that the piston is free from cracks. The piston should be firmly attached to the rod, and be turned to a very smooth surface. After boring the cylinder it is good practice to go over it with a hand scraper to remove all loose metal. This will help out when breaking in. The rings should not be turned too smooth, because a quicker and better seating will be obtained if of a somewhat coarser finish than the piston.

The piston rod should be measured, and if worn so that the diameter is as much as .005 inch less at one point than at other points it is a good investment to true it up. While .005 inch is a small amount, a rod cannot be kept from leaking unless it is true. If the material in the rod is too soft and frequent machining is necessary, even with good packing, it is best to renew it. In that case care should be taken in the selection of metal for the rod.

An analysis of the metal in rods that have given good results is as follows: carbon, .60; silicon, .25; manganese, .20; sulphur, .00; phosphorus, .00; chromium, .80; vanadium, .20. This is a heat-treated rod forged at 1,600° F., annealed at 1,375 to 1,450°, hardened in water at 1,450 to 1,525°, and drawn to 300-1,300°. This rod is very tough and takes a good polish; and because of its chrome content is noncorrosive. There are several good steels on the market that can be purchased and turned to size that will match up with the foregoing specifications and give satisfaction. An unsuitable rod is a bad investment at any price.

If the valves are of the plate-valve type, the ground joint should be examined and plates looked over for cracks and uneven surfaces. Seats should be machined if needful: and if guides are worn a repair job is necessary or a new casting must be furnished. Springs should be looked after and replaced if life is gone. Poppet valves require the same careful inspection: and worn parts should be renewed.

On inspection of packing it may be found that renewal is necessary. If the packing is of a costly variety it should be considered in connection with the piston rod. If the packing is ready for renewal while the rod appears to be nearly due for machining and, under ordinary circumstances, would run another season, still it is good business to machine the rod ahead of time in order to purchase packing to fit.

Overhauling of packing will vary with the type, and the engineer must use judgment according to the conditions he finds on inspection. In general, if of the full-floating type, he will take out rings and clean and examine for wire edges and cracks, and renew wiper rings if of other types and showing too much wear. Renew soft packing if it is so hard that carbon has formed on the surface, endangering the rod polish.

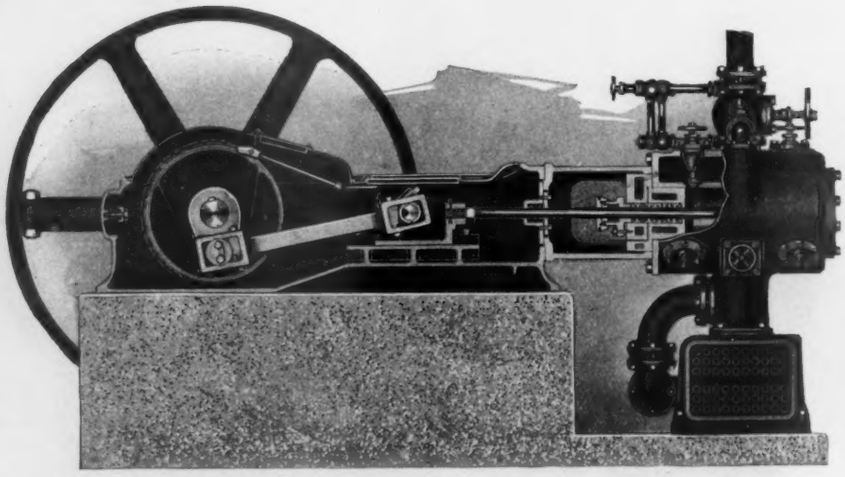
Packing may be classified as of the following types: soft packing; semimetallic, nonfloating; full-metallic, nonfloating; full-metallic, floating. Soft packing should be used only on worn rods and rods out of line. Frequent renewal, close attention, and plenty of oil are necessary when using this type. It runs up the power bill, but is essential under some conditions.

When rods are in line and in good condition, one of three different types of metallic packing may be used: the semimetallic, nonfloating requires attention and will heat under certain operating conditions, while the full-metallic, nonfloating and the full-metallic, floating will not heat more than to take on the heat of compression and will require less attention than other packing. If the rod is of good material and is kept oiled it will not wear, and leaks will be less than where soft packing is used.

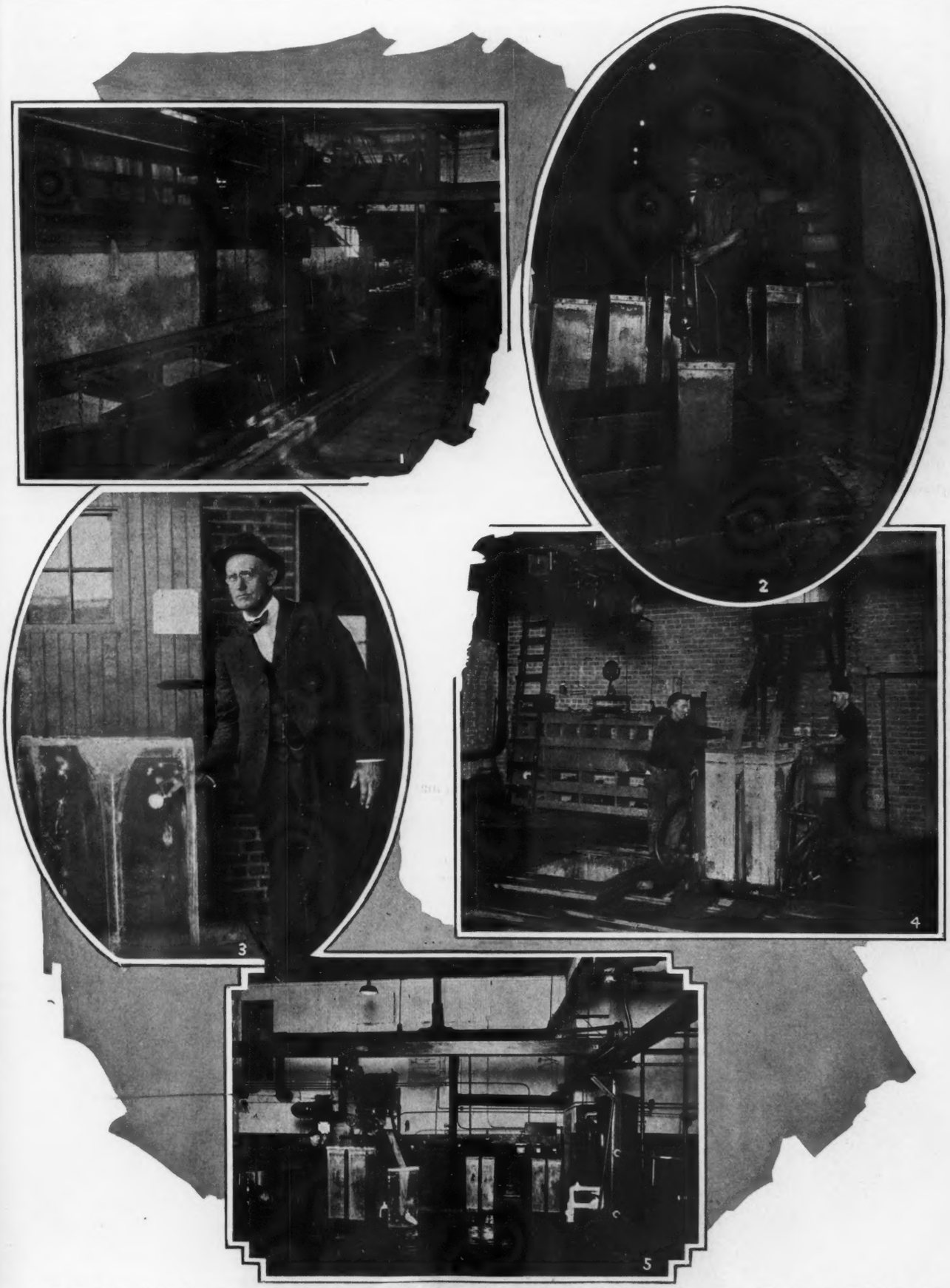
It is good practice to inspect the compressor occasionally for cracks. These, if present, can generally be located more easily when the machine is running, since they can be seen opening or closing—especially if there is some oil on the surface. If detected, their progress can sometimes be arrested by the use of bolts and clamps. Judgment must be used, depending on conditions; but the main thing is to have knowledge of their presence or absence.

Machines are at times found to be loose on their foundations. If too loose the condition will soon get worse and, generally, it is better to raise the machine, pick off the oil-soaked concrete, and regrout. An oil-proof grouting can be made as follows: 200 pounds of clean sharp sand, 125 pounds of good Portland cement, and 25 pounds of No. 7 Smooth-On. Anchor bolts in all cases must be tight.

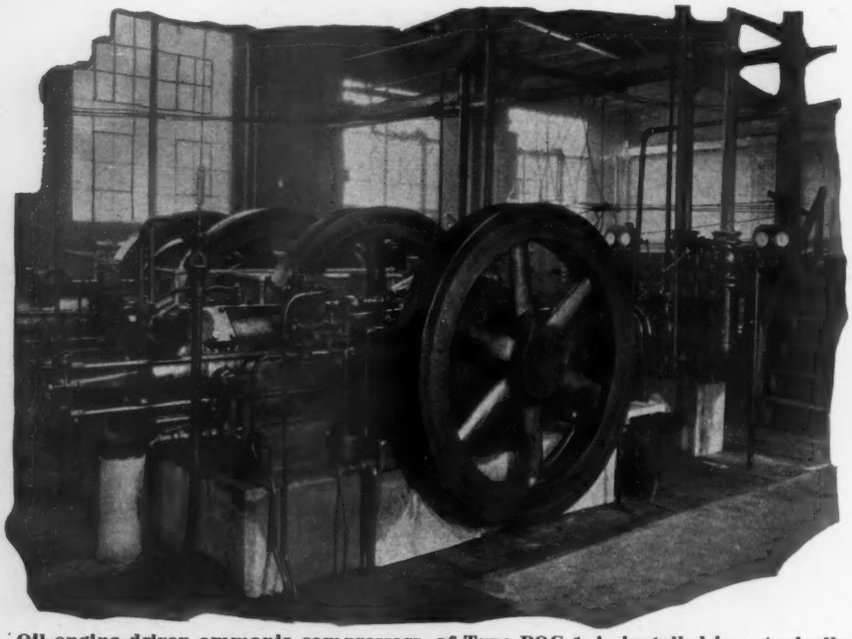
Generally speaking, inspection during the season's run will guide the operator in relation to the oiling system. Lines should be cleaned, and filters taken apart and washed out so that they will do properly the work of purifying the oil supply. The mechanical lubricator should be most rigidly examined



Longitudinal section of a belt-driven ammonia compressor of the XRB-A type.



1—Dumping ice simultaneously from ten cans. 2—Inserting an automatic filler in an ice can. 3—The kind of clear ice now made from raw water when agitated with compressed air. 4—Filling two cans at the same time with filtered and precooled artesian well water. 5—Part of the tank room in the up-to-date refrigerating department of a milk and cold-storage plant.



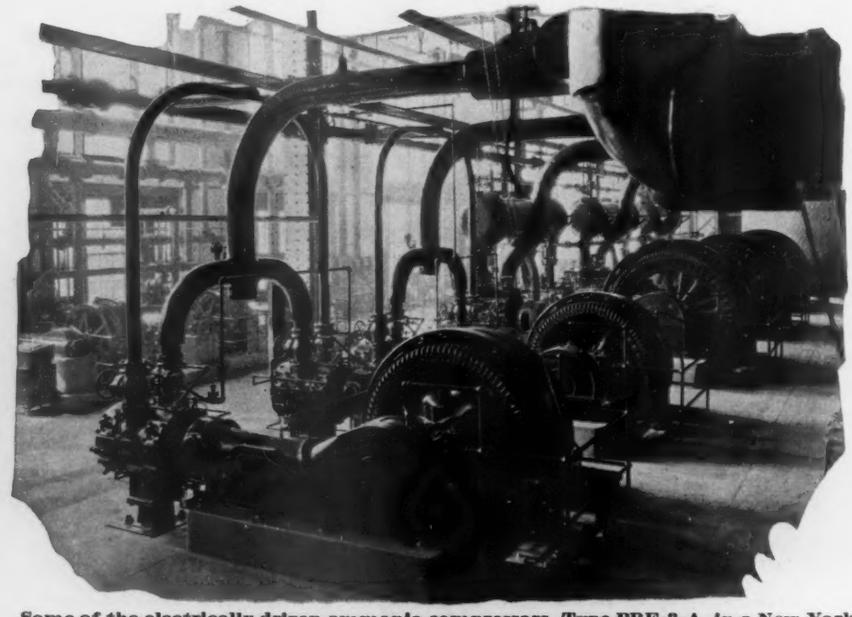
Oil-engine-driven ammonia compressors, of Type POC-1-A, installed in a typically modern ice and cold-storage plant in southern New Jersey.

and repaired, if necessary. This little mechanical apparatus performs a most important task, that of lubricating the cylinder and the rod.

When breaking in a newly machined part, such as a cylinder, rod, or bearing it has been found to be a good investment to provide a supply of defloculated graphite. This graphite is set up as being 99-95 per cent pure carbon and so fine that its particles are said to be 1-40,000th of an inch in diameter. These fine particles of carbon are the very best lubricant obtainable, and fill the pores of the metal —furnishing a very fine skin that will protect the bearing for a long time. The defloculated graphite is used in the oil. Ordinary commercial graphite is not as suitable for this job.

While not a part of the overhauling job, strictly speaking, if it is decided to rebore a cylinder and to fit a new piston, it is good practice to consider any available protection against the wearing out of the new set-up. In this connection a scale trap on the suction line and one on the pump out line play most important parts.

In one case we operated a 14½x28-inch cylinder for two years without any apparent wear. During a recent construction job it was necessary to use the machine, working on a pump out line unequipped with a scale trap. The result was a scored cylinder. This unit was equipped with a scale trap on the main suction.



Some of the electrically driven ammonia compressors, Type PRE-2-A, in a New York City plant that are capable of turning out 1,000 tons of ice a day.

In this paper the writer has endeavored to cover, in a general way, all the points involved in ammonia-compressor inspection and overhauling. However, the great variety of conditions under which the several types of units work demands that judgment be used to get the best job on the particular unit undergoing repairs. Likewise, the repair job will vary with the type of machine, whether horizontal double-acting, or vertical single-acting.

The main bearings should be taken apart and inspected for cracks and loose metal. Wedge bolts should also be examined. All dirt and wire edges should be removed; and, when assembling, proper clearance should be given by taking out shims or otherwise making adjustments. Crank-pin bearings should be scraped so there is a clearance between pin and bearing at the point where the two halves meet at shims. This clearance should be carried back far enough toward the crown of the bearing to guarantee that the bearing will not pinch on the points during operation. When fitting bearings, babbitt as against brass should be used wherever possible.

When inspecting for repairs, a check should be made for alignment and thickness of metal noted to see whether there is enough to carry over another season. For all except crank-pin bearings any good grade of babbitt will be satisfactory. However, it should be a hard babbitt, to the point where it will crack. Newly babbitted bearings should be well tinned before babbitt is poured, and care should be taken that babbitt is not burned in heating. For crank pins a special metal is desirable on account of shock. This metal should be a very tough babbitt that will stand shock without cracking.

Cross-head pins should be flattened on top and bottom—the flattened parts being one-sixth of the circumference of the pin for each flat. This avoids shoulders being worn on pin. For this bearing, lead bronze, as well as babbitt, is used with success.

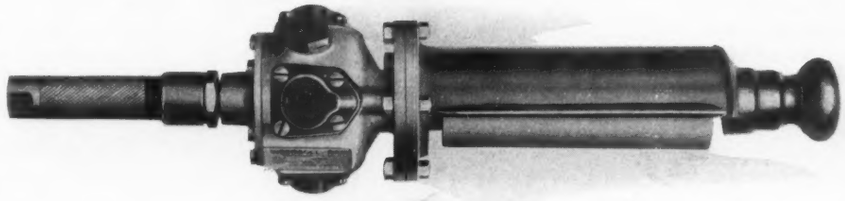
TALL BUILDING TO FURNISH WIND-PRESSURE DATA

WITH the completion of the American Insurance Union Building, in Columbus, Ohio, there has been provided a full-sized test specimen for the study of wind effects upon high buildings. In the past this work has been confined largely to wind-tunnel experiments, with miniature buildings, conducted by the United States Bureau of Standards; but these models were found to be too small to reveal the part played by the powerful vacuum created on the leeward side of a building and believed to be responsible for much of the damage following in the wake of winds of high velocity.

The building in question is the outcome of attempts to furnish standard data that will serve as a basis in computing the wind bracing necessary for different structures; and the observations in regard to pressures, stresses, and elastic deformation are to be made by members of a research fellowship established for that purpose at the Ohio State University, in the City of Columbus, by the American Institute of Steel Construction.

Air-Driven Grinder of Novel Type For Locomotive Repair Work

AN air-operated tool for grinding main and side rods is the latest addition to the equipment devised for locomotive repair shops. The purpose of the new and effective tool is to aid such shops in doing their work well and rapidly.



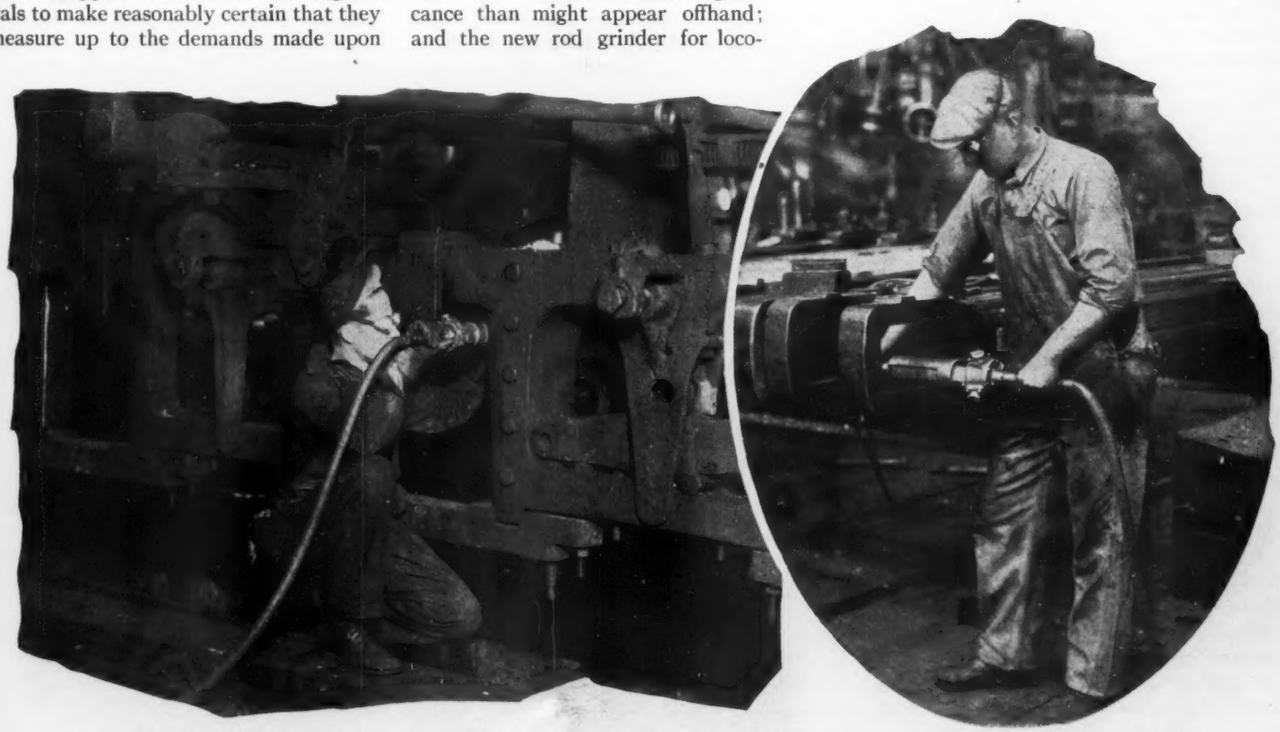
Type No. 63 Rod Grinder.

The modern locomotive repair shop operates on a production schedule that is far more exacting than was the case when compressed air did not play the large part it now does in facilitating the speedy performance of many jobs formerly done by hand and at a very considerable expenditure of time and labor. With the introduction of compressed air as a motive medium, the wide-awake superintendent and his associate foremen have found more and more ways to make use of it. Similarly, manufacturers of pneumatic tools have directed their engineering skill to the developing and the making of a variety of air-driven tools and appliances that would assist in standardizing shop practices and in doing economically the diversified jobs required in keeping locomotives fit for their respective duties.

At the present time, there are in use approximately 70,000 locomotives; and these must be "shopped" at more or less regular intervals to make reasonably certain that they will measure up to the demands made upon them under all sorts of service and weather conditions. Out of every dollar of operating revenue earned—according to the 1926 figures—73.23 per cent is absorbed by operating expenses. It should therefore be apparent how necessary it is to keep every locomotive engaged in revenue-making work as many days as possible in the course of a year. In the last analysis, the burden of this readiness and fitness for service hinges not only upon the way but also upon the rapidity with which the repair work is done in the shops. The more ton-miles of freight hauled or the greater the number of miles covered in passenger service during a twelvemonth, the larger the revenue earned on the investment represented by the locomotives used. The benefits of this amplified service are shared both by the general public as well as by the railroads. Hence, any mechanical agency that contributes to this end is a matter of wider significance than might appear offhand; and the new rod grinder for locomotive shops is no exception to this rule.

The Ingersoll-Rand Company, 11 Broadway, New York City, has lately added to its portable pneumatic tools what is designated as their No. 63 Rod Grinder. This tool takes a grinding wheel that has a 6-inch face; and it is provided with an outboard bearing and a hand grip. It has been developed primarily for grinding locomotive side and main rods, as well as valve motion rods, and for polishing work in connection with such rods.

The grinder is compact and of light construction; and its wide-faced wheel makes it conspicuously suitable for grinding any expansive surface that should have a smooth finish. Some of its other applications in railroad-shop routine work include grinding welds on side rods; grinding brasses to fit main rods; grinding the jaws in main rods to smooth them to receive brasses; grinding the relief on the brasses after they have been fitted to the rods; grinding frame jaws for reseating wedges; and grinding holes in frames for refitting brake pins. A tool capable of doing the things mentioned can be utilized to advantage in numerous other ways. While the



Left—Grinding the frame of a locomotive preparatory to reseating wedges. Right—Grinding jaws of a locomotive main rod in making them ready for new brasses.

machine, itself, is new, its construction is, nevertheless, the same as that of other Ingersoll-Rand portable grinders which, during years of service, have proved of a high order and uniformly satisfactory.

The air motor is made up of three cylinders spaced symmetrically about the center line of the spindle; and all the cylinders deliver power to a single crank pin. This arrangement, together with a counterweighted crank, is effective in minimizing vibration, and insures a steady torque at the spindle. Each cast-iron cylinder is separate from the aluminum case; and all are interchangeable and readily removable. This is a valuable feature, inasmuch as any cylinder, after long service, may need to be replaced.

The valve, the crank, and the spindle are in one piece. This obviates the employment of an intermediate valve or a spindle driving mechanism that might wear and cause trouble. In the present tool, the valve cannot get out of time. The crank spindle is supported by three sets of ball bearings which reduce friction to the lowest practicable point and keep the valve portion from bearing on its bushing and occasioning wear.

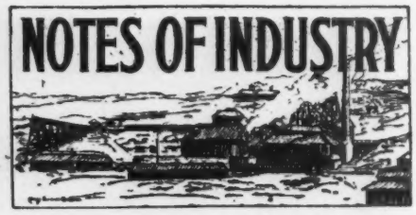
The grinding wheels for the grinder are 6 inches long and 2½ inches in diameter, and have an arbor hole 9/16 inch in diameter. The wheels are made of two different grits and in two grades. The weight of the tool complete, with grinding wheel in place, is 16¼ pounds, and the length overall is 23¼ inches. The average free speed is 6,000 revolutions per minute.

OYSTERS GIVE INFORMATION OF REMOTE PAST

ON the banks of the lower Potomac River at Wailes Bluff, near Cornfield Harbor, Md., may be seen a thick bed of oyster shells, now high and dry above tide level and covered by several feet of earth. How did they get there? Is it a kitchen midden of the long ago, left by the Indians or their predecessors? Geologists say no: the bed is vastly older than that, and the oysters lived and died where they now are and owe their present high position to changes in water level and not to human agency.

This prehistoric oyster bed and adjacent deposits, which include a more varied assortment of shells, are remnants of the Pleistocene period. Although the oysters and other creatures that inhabited these shells existed during the final stages of the Ice Age, nevertheless, says the Geological Survey, the temperature of the sea water must have been about the same at that time as it is today, if not a little warmer, as a kind of clam that now flourishes in Mobile Bay then lived near the mouth of the Potomac River.

Based on population, Norway, with an aggregate of nearly 2,000,000 hp., now leads the world in hydro-electric development. It has been estimated that Norway has 0.72 hp. per capita; Canada about 0.55; Switzerland, which is considered a water-power nation, has 0.46; and the United States only 0.10 hp. per person.



The practice of rock-dusting coal mines as a means of preventing coal-dust explosions is growing. In the State of Pennsylvania, alone, about 200 collieries have adopted this method, which has received the endorsement of the United States Bureau of Mines.

If not too badly worn, discarded automobile casings are in demand, especially in Greek Macedonia and Thrace, for the making of a type of footwear worn by peasants. The *tcharik*, as it is called, was formerly composed of a strip of leather, held to the foot with lacings, which lasted only two months at the most. The rubber *tcharik* wears from eight to twelve months; and one casing provides enough material for three pairs. It is estimated that Greece now imports 50,000 of these old automobile casings for this purpose annually.

All schools, churches, and kindred organizations, interested in highway-safety education, may obtain free of charge from the American Road Builders' Association, Washington, D. C., complete directions for the production of a dramatic pageant that was written purposely for this field of service. The pageant won first prize in a national competition for the best ideas on the promotion of highway safety.

A process for casting stone much in the same way as iron is cast has been devised and put in use, so we learn from the *Scientific American*. The mix consists of 1 part of cement to 3½ parts of marble or granite aggregate—8 gallons of water being required per bag of cement. Three sizes of aggregates are employed, the largest screening through a ½-inch mesh. It is possible, so it is claimed, with this material to cast statuary having the outward appearance of the finest carved stone.

It has been announced by Sir Sefton Branckner, director of civil aviation in England, that the world's first regular airship passenger service is to be inaugurated some time this summer, and probably between England and Canada. Two giant dirigibles—each of which will be capable of carrying comfortably 100 persons—are now being built for this transatlantic route.

A prediction made years ago by de Lesseps, the builder of the Suez Canal, that the Panama Canal would some day outstrip the Suez Canal in tonnage handled, has come true. In 1926, vessels with a gross tonnage of 26,836,000 tons paid tolls for the privilege of using the Panama route, while the traffic through the Suez Canal during the same period aggregated but 26,606,000 tons.

A cotton fabric for use in highway construction has been developed by the United States Bureau of Standards in co-operation with the New Orleans Cotton Textile Institute. The material is of loose mesh, and serves to separate the base from the surface of the roadway. With such a cleavage plane it is possible, in making repairs, to remove the top layer and to put in a new section without impairing the permanent cement foundation. It is estimated that 1,000,000 yards of the new fabric will be utilized in the course of the present year for this purpose.

The water hyacinth, that has proved such a pest in certain of our southern waters, may in future be harvested because of its commercial possibilities. In a recent address before the Indian Science Congress, Prof. H. K. Sen, of the Science College, in Calcutta, stated that he had succeeded in producing pure potassium chloride and power alcohol from the dried plant. The pulp is suitable for the making of strawboard.

French investigators, it is claimed, have succeeded in operating Diesel and semi-Diesel engines with different kinds of fish oil. The heating value of oils from this source, according to a report to the Academy of Sciences, is but little if any lower than that of mineral oils.

The American Road Builders' Association has issued the startling statement that someone is either killed or seriously injured in an automobile accident in the United States every forty seconds. This is an appalling state of affairs, and is ample warrant for any action by the authorities that may be calculated to reduce automobile accidents and their consequences upon passengers and pedestrians.

Low-temperature distillation of lignite under vacuum is being effected, it is reported, in an experimental plant at Drumpeller, Alta., Canada. The raw coal enters a retort and passes through ten tables—being heated gradually by electricity to a temperature of 1,150° F. at the bottom table. During this process, the coal is under vacuum all the time and therefore does not burn. After it is cooled by water, the coal comes out at the bottom in the form of char, having been freed of all volatile matter. The resulting gases are drawn off by a vacuum pump, cooled, and then treated for the extraction of their by-products. The capacity of the unit is a carload of char a day, or 35 tons.

A concession has been granted for the construction of a railroad in Iceland—the first in that sparsely settled region of volcanic origin that depends mainly on horse-drawn vehicles and automobiles as means of transport. The proposed railroad is to be electrically operated, and will extend from Reykjavik, the capital, to Urridafoss, a length of 41 miles. The line will tap the country's richest agricultural district which is now seriously handicapped in getting its produce to market.

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EDITORIALS

WHAT NEXT IN AVIATION?

THE past twelve months have been marked by a number of astonishing aeronautical achievements. CHARLES A. LINDBERGH headed the list of amazing things done by making a non-stop flight from New York to Paris—being aloft 33 hours and 10 minutes, and covering a distance of 3,610 miles. That unparalleled feat has aroused America to a state of air-mindedness that might not have been reached for years to come. He brought home to us suddenly what the modern flying machine is capable of in the hands of a careful, cool-headed, courageous pilot; and, incidentally, revealed what the engineer and the aeronautical designer have contributed towards success.

It is, of course, distressing to recall how many lives were sacrificed in subsequent vain attempts to span the ocean in eastward flights from the American coast, and the list of disasters that beset those fearless airmen that tried to make the westward trip but who disappeared without leaving a trace.

Now that we know what those three brave men encountered that recently succeeded in making the westward flight from Europe to America, there is little cause for wonderment that others were lost in an effort to make the same journey aloft. In short, they had to battle with opposing winds that caused the consumption of precious fuel and greatly reduced headway—winds that no doubt taxed to the utmost the structural strength of some of the aircraft; with sleet and accumulating ice that added dangerously to the weight of the airplane, making it difficult if not impossible to maintain altitude and augmenting the stress on the motive power while draining the fuel reserve just so much faster; and, finally, with what might be considered the worst enemy of the airman, the blanketing banks of fog that enshroud him and bewilder him.

The aeronautical fraternity, in congratulating KOEHL, VON HUENEFELD, and FITZMAURICE, has had every reason to felicitate itself that these brave men succeeded in their desperate undertaking—bringing to an anxious world information of great value scientifically, and potentially of even wider value in advancing the day of regular transatlantic travel by air. We need not deceive ourselves, however, that this method of transportation across the Atlantic will be available to the general public in the near future, or before much has been done to provide navigational safeguards of various kinds.

The unheralded and, therefore, all the more amazing flight of WILKINS and EIELSON from Point Barrow to Green Harbor, Spitzbergen, across the Arctic Ocean, has left us devoid of words wherewith fittingly to express our admiration. It proved what can be done with a skillfully planned and well-equipped machine of relatively small size. Perhaps other things equally thrilling may be achieved by undaunted fliers between the writing and the printing of these lines.

Despite the toll of lives that has been taken in aeronautical ventures since May of last year, still the art of mechanical flight has surged forward at a tremendous pace, focusing public attention upon what has been done to give airplanes structural strength and to provide them with engines capable of keeping some machines aloft for 50 hours and more—the duration of the flight apparently being limited only by the physical endurance of the pilot and the capacity of the fuel tanks.

What must now be done is to furnish more dependable or diversified navigational aids—instrumentalities that can be relied upon to guide the aircraft on her intended course so that precious fuel will not be wasted in perilous groping amid enveloping fog or obscuring storm.

AMERICAN DIESEL ENGINES WIN FAVOR ABROAD

A BRIEF reference is made in the news columns of this issue to the launching on the Clyde of the Diesel-electric tanker *Brunswick*, built for an American oil-refining company. The topic may not appear of especial significance to the general public, because a good many vessels for our merchant fleet have been constructed, from time to time, in European shipyards. The feature of the craft that makes her of outstanding interest to us is that she is being equipped with Diesel engines of essentially American design and built by a well-known Belgian engineering concern under license from an American company.

For years after Dr. RUDOLPH DIESEL blazed the way with a revolutionary departure in the operating principles of internal-combustion engines, most of the notable advances in the designing of such engines had their origin in Europe; and when our own manufacturers began to take up the Diesel engine they worked under European patents. The heavy-oil or Diesel engines for the tanker *Brunswick* are of American design, of thoroughly proved excellence, and original in a number of important engineering features. To the best of our knowledge that type of Diesel engine is the first to be sought by European builders; and the prime movers of this tanker of 12,500 tons dead weight are America's return contribution to the art that had its inception on the other side of the Atlantic. American engineers may take pride in this fact.

MERSEY TUNNEL HAS BEEN HOLED THROUGH

ON THE third of April of the present year, the Mersey Tunnel was holed through at a depth of 136 feet below the level of the river, thus bringing to one construction climax work started on December 16, 1925. Much still remains, of course, to be done before this greatest of subaqueous vehicular highways will be ready for service.

In view of the progress already made, it is believed the tunnel will be completed by 1930; and, when finished, will be another means of linking Birkenhead and Liverpool by an underground route. Up to the present time, the two communities have depended upon ferryboats to transport vehicles bound to and fro between the Lancashire and the Cheshire sides of the river.

A better idea of the magnitude of the undertaking can be had if we recall that the tunnel structure will be nearly three miles long, that the tube has a maximum diameter of 44 feet, and that the passageway for this metal lining is being driven through sandstone—air-operated rock drills being employed in advancing the two headings and in doing the ring drilling for enlargement to full size. The tunnel tube is made up of cast-iron segments bolted together, as has been the accepted practice for years in kindred engineering enterprises. In the upper section of the tunnel there will be a roadway 36 feet wide, accommodating four streams of traffic, and this will be flanked by two footways, each 4 feet wide. Beneath this broad roadway, in the center of the lower segment, will be ample space for two lines of light vehicles.

Work on the tunnel was started on the Liverpool side of the river by the sinking of a shaft through the exposed sandstone; and air for the operation of the rock drills and paving breakers used to excavate the sandstone was released for that purpose by H. R. H. PRINCESS MARY, who turned a valve in the line with a gold key provided for that memorable ceremony. Before the excavating is finished, it will be necessary to remove a total of more than 1,000,000 tons of rock—evidence of the aid rendered by air-driven drills.

Owing to fissures in the sandstone, much water now enters the tunnel, and this will be prevented subsequently by forcing grout, with compressed air, into the space between the rock and the exterior of the tube, and, incidentally by causing this fluid cement to

penetrate crevices in the sandstone through which water flows or seeps at the present time. The estimated cost of the enterprise has been placed at approximately $25,000,000.

In carrying out the work, a number of novel methods or expedients have been employed to combat the physical conditions encountered; and the rate of progress made reflects great credit upon all those directly concerned in advancing this notable public improvement. Steadily growing vehicular traffic in that part of England made it necessary either to bridge the Mersey or to build a commodious subaqueous tunnel; and after much deliberation the authorities were convinced that a tunnel was the logical solution of the difficulty.

LEANING TOWER OF PISA TO BE STEADIED

PISA, without its Leaning Tower, would be worse off than the widely known pretzel without its salt—because salt on the pretzel is a matter of taste, and tastes differ. The popularity of Pisa, at least to the tourist who brings money to the city's coffers, has for a long while centered around its campanile that has stood out of plumb and defied for hundreds of years the force of gravity that threatened to lay it prone.

The Leaning Tower was begun in 1174. It is 181 feet high; has a diameter of 51½ feet at the base; and inclines 13 feet 8 inches toward the south. A good half of the settlement of the structure that put the tower out of perpendicular occurred while the campanile was building; and further subsidence, from time to time in the centuries gone, has increased the tilt.

Bearing in mind what befell the Campanile at Venice, the civic authorities of Pisa have shrewdly determined to take steps that would safeguard their chief architectural attraction against collapse. To this end they have contracted, according to news from abroad, with a Swedish concern whose task it will be to consolidate the underlying ground so as to provide a firm or firmer foundation for the tower. At the moment we do not know how this will be achieved, but it is more than likely that concrete and, possibly, grouting will be employed that can be forced into place with compressed air.

Modern engineering facilities could, undoubtedly, be so marshaled that this ancient edifice could be made to stand straight, as it was intended to do originally, but such a rectification would ruin the tower as a show feature of Pisa. The astute officials of the city have realized this, and are confining their efforts merely to preserving the campanile "as is".

A CORRECTION

Our attention has been called to the fact that the picture appearing on page 2341 of our March 1928 issue, and used in illustrating the article on *Songhees Graving Dock Near Victoria*, is an airplane view of the Harbor of Victoria and not of Vancouver as was incorrectly stated.

AMERICAN PROSPERITY: ITS CAUSES AND CONSEQUENCES, by Paul M. Mazur. A work of 268 pages, published by the Viking Press, New York City. Price $2.50.

GENERALLY speaking, America is a prosperous nation—an amazingly prosperous nation, and many foreign students of economic conditions have come to this country recently in an effort to find out just why we are so prosperous. Some have attributed our economic pre-eminence to one thing, while others have found still different reasons for our success in business and in industry. The author contributes his views as a banker who, in a sense, stands by the roadside and watches the industrial procession as it travels onward—at a swift speed in some cases, slower but certainly in other cases, while here and there still others falter or fall by the way.

As he expresses it, "The possibility of tracing the forces of business economics, recently unleashed, will be enhanced if the search is made along the roadway of business and not from some isolated library. Perhaps such a point of view may seem invalid to some; nevertheless it is the motive which prompted the writing of this book. Here will be found a non-statistical, non-academic observation of the forces that business has evoked, the conflicts that exist between them, and a guess as to the outcome. The only materials used have been my observations of business methods."

In conclusion, the writer says: "But America is not dollar-mad in the miser's manner. It is activity-mad. It likes the game of business; and it keeps score in dollars..... If possession of money were the real end, America would be parsimonious, and it would also seem unlikely that the industrial leader would continue his risk when it would be so much safer to withdraw and hoard his money. So long as there is an urge for the American businessman to reach the top of the industrial heap, he will experience no softness of mind, no flabbiness of body, no diminution of energy."

MODERN BLASTING IN QUARRIES AND OPEN PITS, by J. Barab. A copiously illustrated book of 169 pages, published by the Hercules Powder Company, Wilmington, Del. Price $3.00.

GREAT quantities of explosives are used annually in the United States in mining, in quarrying, in farming, and in numerous fields of engineering where rock or earth have to be blasted for different purposes. It is because explosives are employed so extensively in industry in attacking nature's ever-changing geological formations, and by men of widely different experience, that it has been deemed advisable—in an effort to promote both efficiency and safety—to compile this volume. The work is a veritable storehouse of valuable information in the use of explosives in the industrial departments referred to in the title; and the company responsible for the book is to be commended for its enterprise and for the thoroughness with which it has covered this important subject.

THE HISTORY OF THE INCANDESCENT LAMP, by John W. Howell and Henry Schroeder. An illustrated volume of 208 pages, published by the Maqua Company, Schenectady, N. Y.

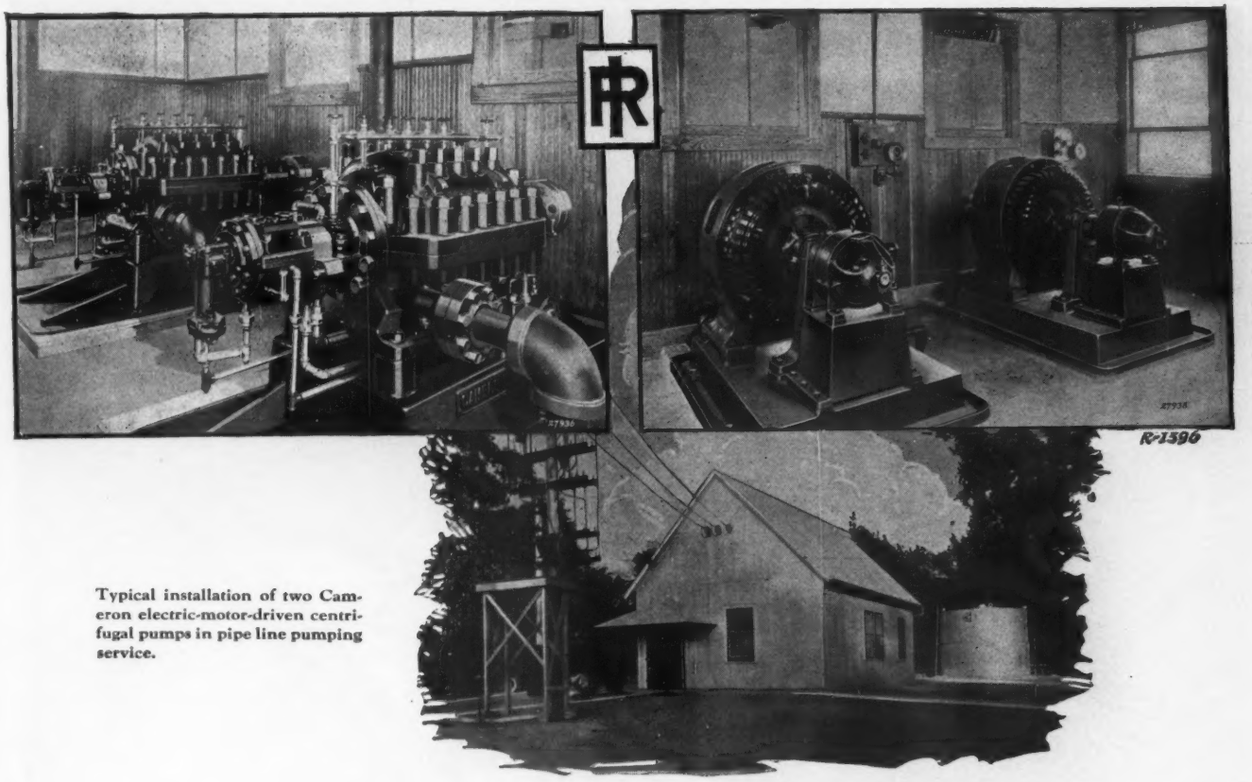
THE incandescent lamp, as we know it in the home and the place of business, costs so little and does so much for our comfort and convenience that we accept it as a factory product turned out in enormous quantities and give little if any heed to its origin and to the steps by which it has been brought to its present excellence. This book fills a long-felt want, and tells the story of the incandescent lamp from the first days of its inception on down to the means and the processes by which it is now produced. The subject is handled in a clear and interesting manner.

THE ZEPPELINS, by Captain Ernst Lehmann and Howard Mingos. An illustrated book of 329 pages, published by J. H. Sears & Company, Inc., New York City. Price $4.00.

THE co-authors have produced an extremely interesting and informative book covering the story of Germany's great dirigibles from the pioneer efforts of Count Zeppelin down to the present day. Naturally, the World War gave to the building of this particular type of airship an impetus that might have been delayed for years. Because of military necessities, money was spent and engineering skill was directed to the development of Zeppelins that took but little account of the magnitude of the expenditures involved. Thus things were done, difficulties were mastered that would have staggered the nation in time of peace; and in this way was attained a momentous advance in the art of building lighter-than-air craft. America and other nations have profited by this. Of course, the most spectacular part of the book is devoted to the wartime operations of the Zeppelins; and in the presentation of this phase of the subject the authors have told their story well—carefully avoiding anything calculated to arouse animosity. In conclusion, much is suggested regarding the possible services for this order of aircraft in war and in commercial fields in the years to come.

The National Flue Cleaner Company, Inc., Groveville, N. J., has just published a bulletin describing its soot blower for return tubular boilers. Copies will be furnished gladly, upon request, by the company concerned.

Belt Dressing Facts is the name of a new 12-page booklet just published by E. F. Houghton & Company, Philadelphia, Pa., that contains much valuable information on the proper care of belts under the following sub-heads: Belt lubricant essential; Liquid lubricant is best; Avoid sticky dressings; Slack belts undesirable; Loose belts waste power; What a dressing should do, etc. Every belt user should have a copy.



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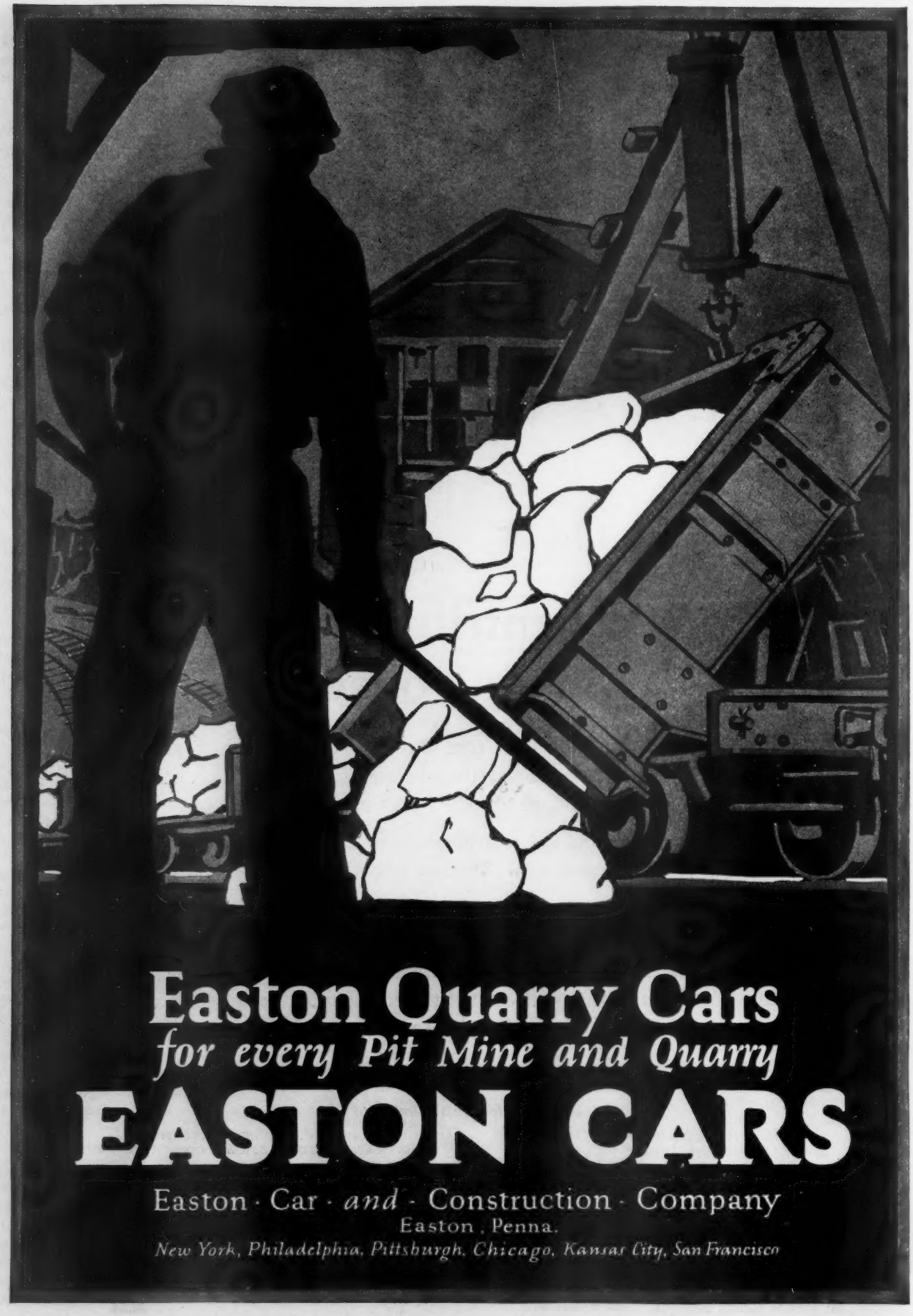
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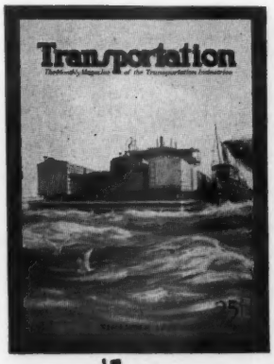

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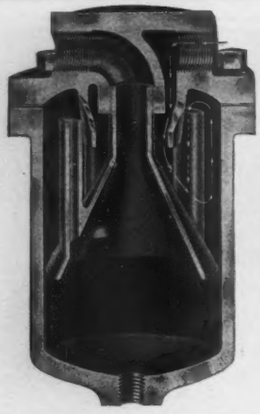

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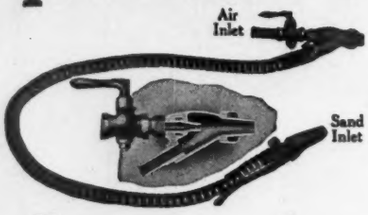

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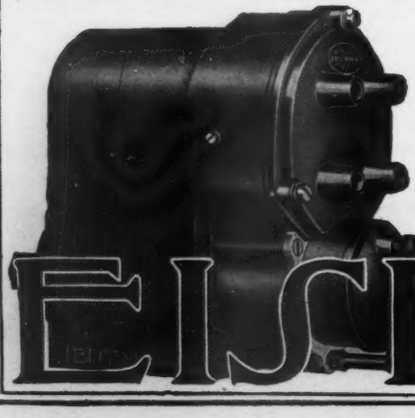

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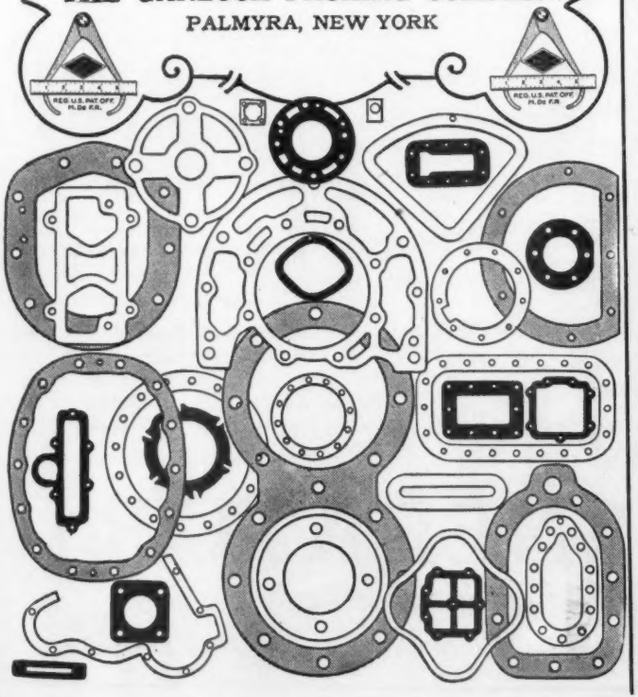

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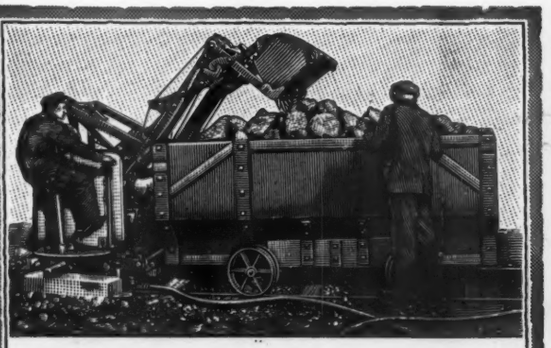

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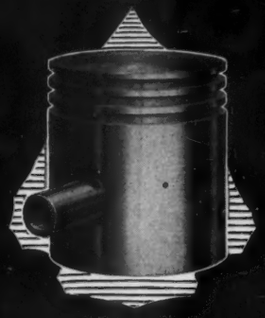

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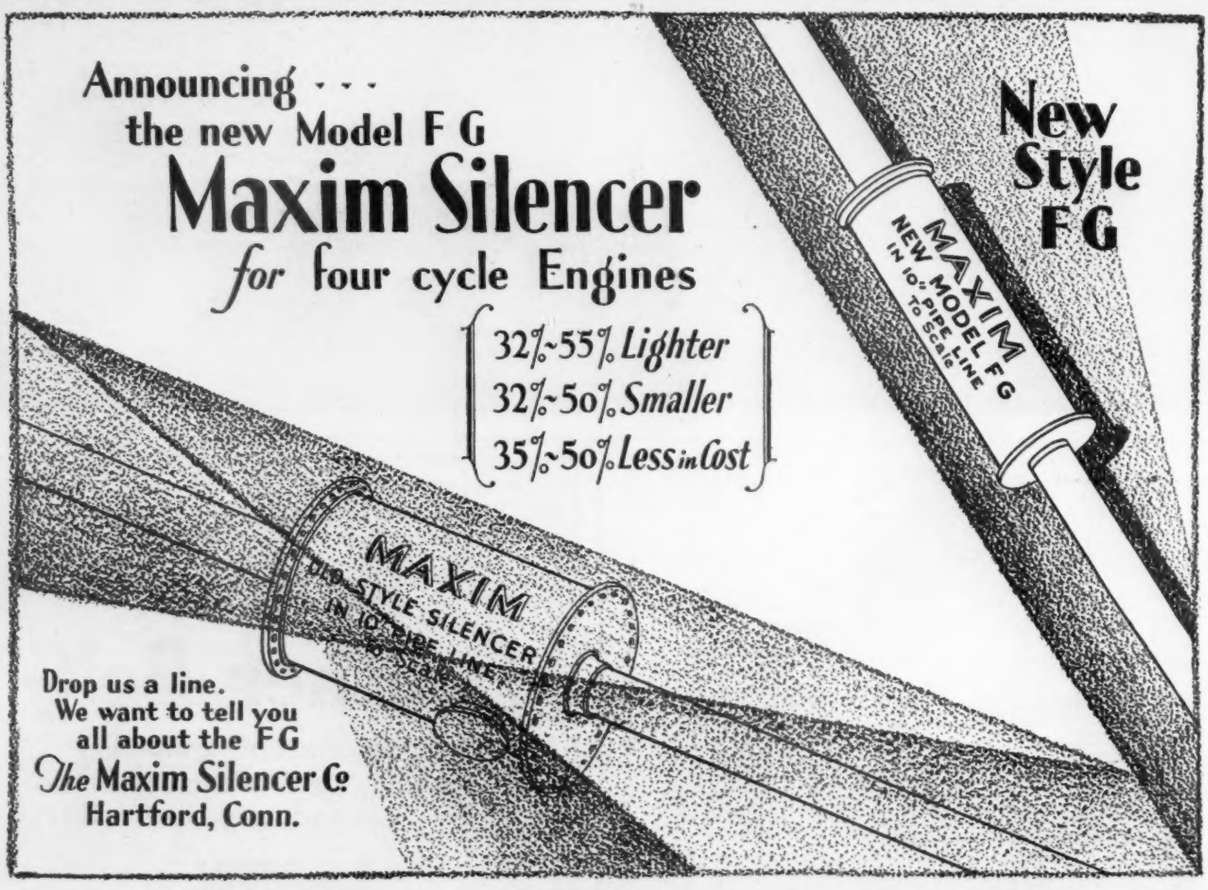

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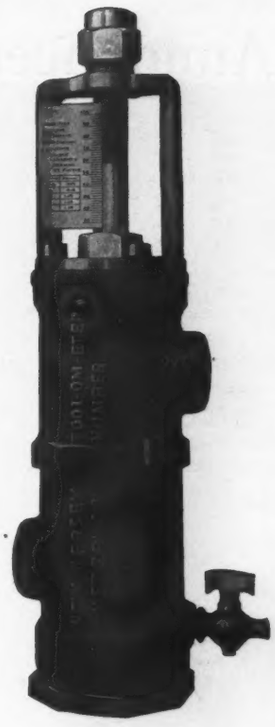

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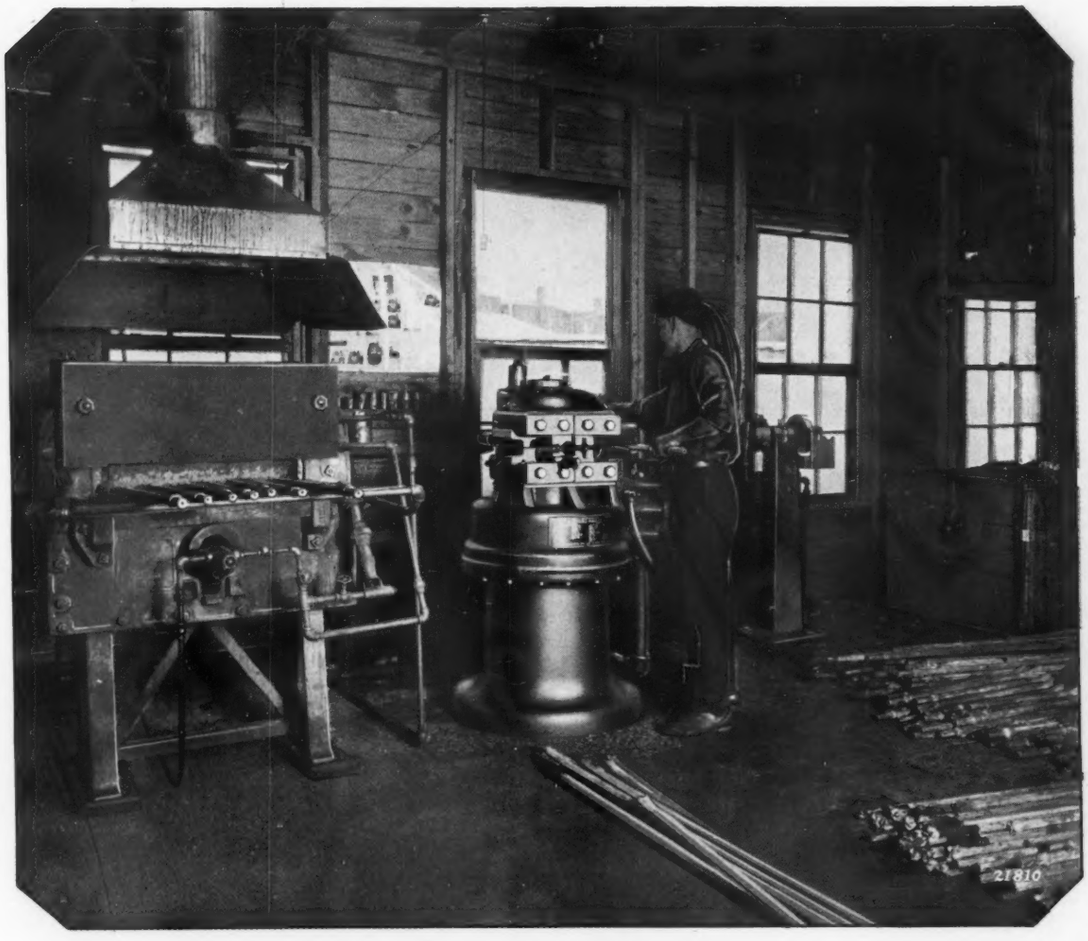

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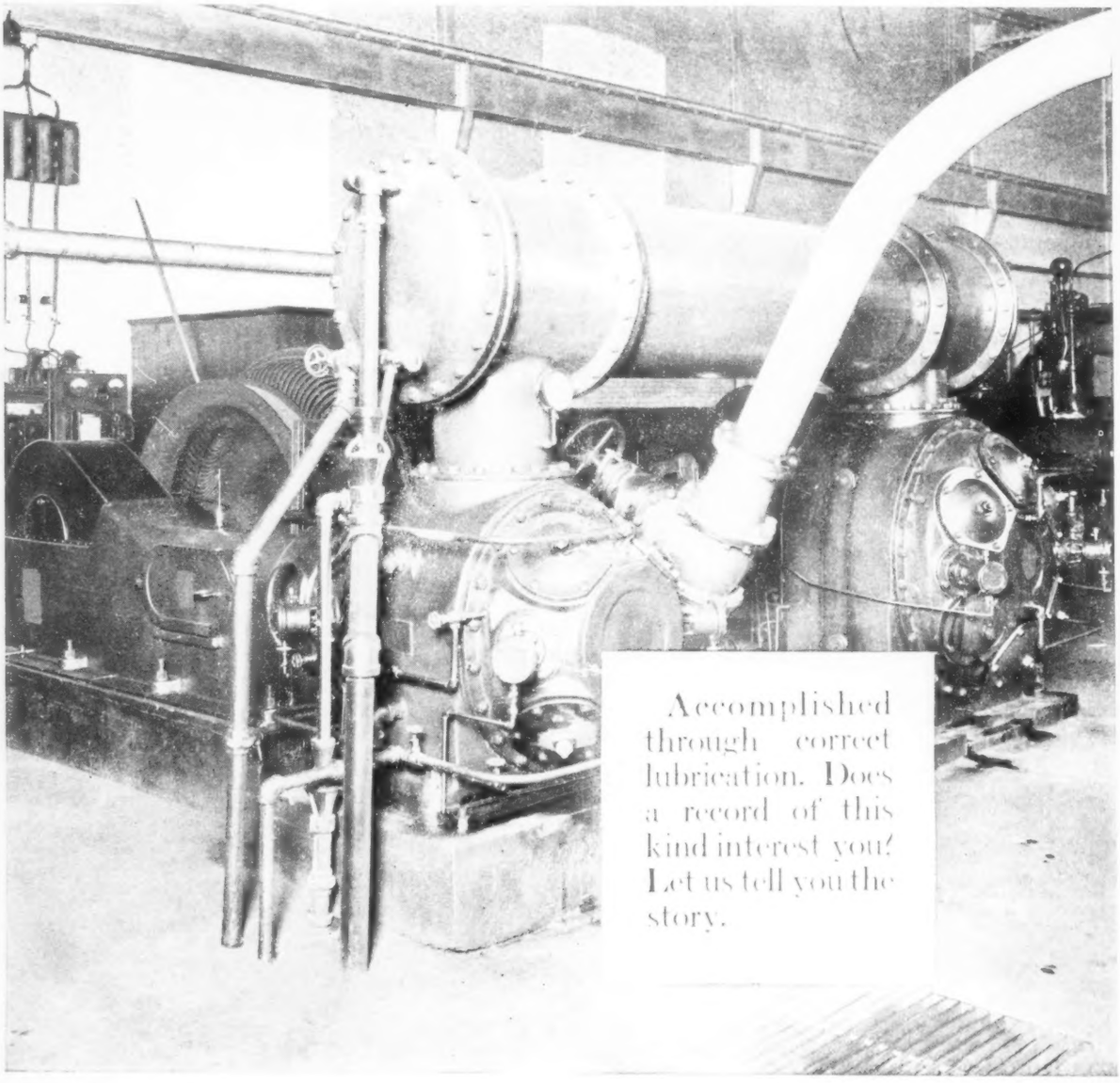

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